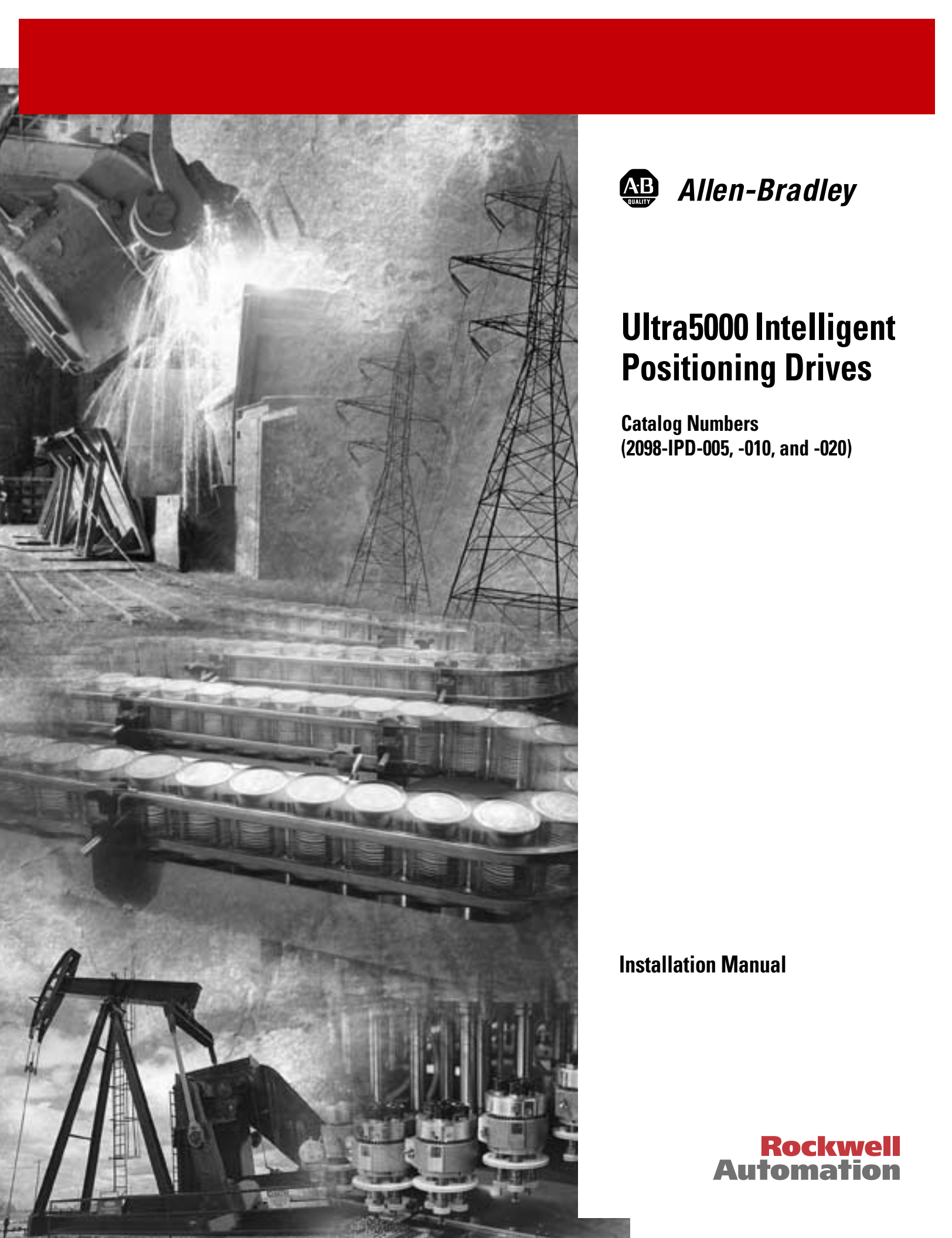




Allen-Bradley

Ultra5000 Intelligent Positioning Drives

**Catalog Numbers
(2098-IPD-005, -010, and -020)**

Installation Manual

**Rockwell
Automation**

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley® does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss

Attention statements help you to:

- identify a hazard
- avoid a hazard
- recognize the consequences

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

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Preface

Introduction

Read this preface to familiarize yourself with the rest of the manual. This preface contains the following topics.

- Who should use this manual
- The purpose of this manual
- Contents of this manual
- Related documentation
- Conventions used in this manual
- Product receiving and storage responsibility
- Allen-Bradley support

Who Should Use this Manual

Use this manual for designing, installing, programming, or troubleshooting the Ultra5000 Intelligent Positioning Drive (IPD). If you do not have a basic understanding of the Ultra5000, contact your local Allen-Bradley representative for information on available training courses before using this product.

Purpose of this Manual

This manual describes the function and installation of the Ultra5000 products and standard Rockwell Automation/Allen-Bradley motors recommended for use with the Ultra5000. The manual is intended for engineers or technicians directly involved in the installation, operation, and field maintenance of the Ultra5000.

Contents of this Manual

Refer to the following listing for the descriptive contents of this installation manual.

Chapter	Title	Contents
	Preface	Describes the purpose, background, and scope of this manual. Also specifies the audience for whom this manual is intended.
1	Installing Your Ultra5000	Provides mounting information for the Ultra5000.
2	Connecting Your Ultra5000	Provides connection and wiring information for the Ultra5000.
3	Commissioning Your Ultra5000	Outline steps when applying power to equipment for the first time.
4	Maintaining Your Ultra5000	Diagnostic aids that help isolate problems to a system module.
Appendix A	Specifications and Dimensions	Provides physical, electrical, environmental, and functional specifications for the Ultra5000.
Appendix B	Options and Accessories	Provides identification numbers and descriptions of the Ultra5000 and related products.
Appendix C	Application Information	Provides information for specific applications.

Related Documentation

The following documents contain additional information concerning related Allen-Bradley products. To obtain a copy, contact your local Allen-Bradley office or distributor.

For information about	Read This Document	Product Number
Configure and operate Ultra5000 drives	<i>Ultraware™ User Manual</i>	2098-UM001A-EN-P
Ultra5000 Programming Instructions	<i>Ultraware™ Programming Manual</i>	2098-PM001A-EN-P
Ultraware Installation Instructions	<i>Ultraware CD Installation Instructions</i>	2098-UM002A-EN-P

Conventions Used in this Manual

The following conventions are used throughout this manual.

- Bulleted lists such as this one provide information, not procedural steps
- Numbered lists provide sequential steps or hierarchical information
- Words that you type or select appear in bold
- When we refer you to another location, the section or chapter name appears in italics

Product Receiving and Storage Responsibility

You, the customer, are responsible for thoroughly inspecting the equipment before accepting the shipment from the freight company. Check the item(s) you receive against your purchase order. If any items are obviously damaged, it is your responsibility to refuse delivery until the freight agent has noted the damage on the freight bill. Should you discover any concealed damage during unpacking, you are responsible for notifying the freight agent. Leave the shipping container intact and request that the freight agent make a visual inspection of the equipment.

Store the product in its shipping container prior to installation. If you are not going to use the equipment for a period of time, store using the following guidelines.

- Use a clean, dry location
- Maintain an ambient temperature range of -40 to 70°C (-40 to 158°F)
- Maintain a relative humidity range of 5% to 95%, non-condensing
- Store it where it cannot be exposed to a corrosive atmosphere
- Store it in a non-construction area

Allen-Bradley Support

Allen-Bradley offers support services worldwide, with over 75 Sales/Support Offices, 512 authorized Distributors and 260 authorized Systems Integrators located throughout the United States alone, plus Allen-Bradley representatives in every major country in the world.

Local Product Support

Contact your local Allen-Bradley representative for:

- Sales and order support
- Product technical training
- Warranty support
- Support service agreements

Technical Product Assistance

If you need to contact Allen-Bradley for technical assistance, please review the information in the *Maintaining Your Ultra5000* chapter first. Then call your local Allen-Bradley representative. For the quickest possible response, please have the catalog numbers of your products available when you call.

Installing Your Ultra5000

Chapter Objectives

This chapter covers the following topics:

- Complying with European Union directives
- Before mounting your system
- Bonding your system
- Mounting your Ultra5000 drive

ATTENTION



The following information is a guideline for proper installation. The National Electrical Code and any other governing regional or local codes overrule this information. The Allen-Bradley Company cannot assume responsibility for the compliance or the noncompliance with any code, national, local or otherwise, for the proper installation of this system or associated equipment. If you ignore codes during installation, hazard of personal injury and/or equipment damage exists.

Complying with European Union Directives

If this product is installed within the European Union or EEC regions and has the CE mark, the following regulations apply.

EMC Directive

This unit is tested to meet Council Directive 89/336 Electromagnetic Compatibility (EMC) using a technical construction file and the following standards, in whole or in part:

- EN 5008x-2 EMC - Emission Standard, Part 2 - Industrial Environment
- EN 5008x-2 EMC - Immunity Standard, Part 2 - Industrial Environment

The product described in this manual is intended for use in an industrial environment.

To meet CE requirements, the following additions are required:

- You must run single-phase input wiring in a conduit that is grounded to the enclosure.
- You must install a power line filter (Allen-Bradley catalog number 2090-UXLF-106, 2090-UXLF-110, 2090-UXLF-123 or equivalent based on system current) between the single-phase input line and the system module input.
- You must terminate the shields of the motor power cables and the motor feedback cables to the enclosure at the point of entry.

Low Voltage Directive

These units are tested to meet Council Directive 73/23/EEC Low Voltage Directive. The *EN 60204-1 Safety of Machinery-Electrical Equipment of Machines, Part 1-Specification for General Requirements* standard applies in whole or in part.

Refer to *Appendix C* for interconnect information.

Before Mounting Your System

Before you mount your Ultra5000 system make sure you understand the following:

- how to store your Ultra5000 before installation
- how to unpack the system
- the minimum mounting requirements

Storing Your Ultra5000 Before Installation

The Ultra5000 should remain in the shipping container prior to installation. If the equipment is not to be used for a period of time, store it as follows:

- Use a clean, dry location
- Maintain an ambient temperature range of -40 to 70°C (-40 to 158°F)
- Maintain a relative humidity range of 5% to 95%, non-condensing
- Store it where it cannot be exposed to a corrosive atmosphere
- Store it in a non-construction area

Unpacking Modules

Each Ultra5000 ships with the following:

- One Ultra5000 drive
- One screwdriver
- One instruction manual (publication 2098-IN001B-EN-P)
- Two I/O connector plugs (14 and 28 pin)

Remove all packing material, wedges, and braces from within and around the components. After unpacking, check the item(s) nameplate catalog number against the purchase order.

System Mounting Requirements

There are several things that you need to take into account when preparing to mount the Ultra5000:

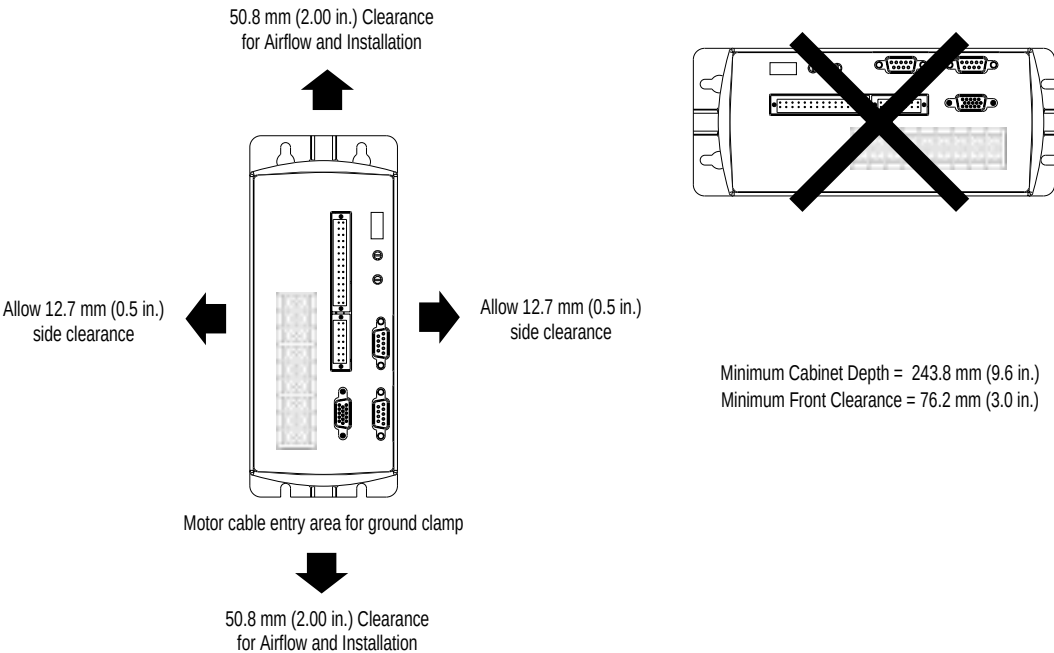
- The Ultra5000 must be enclosed in a grounded conductive enclosure offering protection as defined in standard EN 60529 (IEC 529) to IP55 such that they are not accessible to an operator or unskilled person. A NEMA 4X enclosure exceeds these requirements providing protection to IP66.
- The ambient temperature of the location in which you will install the Ultra5000 must not exceed 55° C (131° F).
- You must install the panel on a flat, rigid, vertical surface that won't be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors.
- You need to maintain minimum clearances (refer to Figure 1.1) for proper airflow, easy module access, and proper cable bend radius.

Refer to *Appendix A* for mounting dimensions, power dissipation, and environmental specifications for the Ultra5000.

Ventilation Requirements

This section provides information to assist you in sizing your cabinet and locating your Ultra5000 drive(s) inside the cabinet.

Figure 1.1
Minimum Clearance Requirements



IMPORTANT

If the cabinet is ventilated, use filtered or conditioned air to prevent the accumulation of dust and dirt on electronic components. The air should be free of oil, corrosives, or electrically conductive contaminants.

Use the following approximate equations as an aid in sizing an enclosure when no active method of heat dissipation is available.

Metric	Standard English
$T_C = 79.05 (Q/A) + 1.98$	$T_F = 4.08 (Q/A) + 1.1$
Where T is temperature difference between inside air and outside ambient (°C), Q is heat generated in enclosure (Watts), and A is enclosure surface area (m ²). The exterior surface of all six sides of an enclosure is calculated as	Where T is temperature difference between inside air and outside ambient (°F), Q is heat generated in enclosure (Watts), and A is enclosure surface area (ft ²). The exterior surface of all six sides of an enclosure is calculated as
$A = 2dw + 2dh + 2wh$	$A = (2dw + 2dh + 2wh) / 144$
Where d (depth), w (width), and h (height) are in meters.	Where d (depth), w (width), and h (height) are in inches.

Transformer Sizing

The Ultra5000 does not require isolation transformers. A transformer may be required, however, to match the voltage requirements of the controller to the available service. To size a transformer, the power output (KVA) of each axis must be known. This can be derived by calculating the horsepower for each axis and converting that horsepower into units of watts. If you are supplying power to more than one motor and an Ultra5000, simply add the KW ratings together from each calculation to get a system KW total.

Definitions:

KW = power or real power

KVA = apparent power

Transformer KVA rating = (Sum of average output power of each axis) x 2.0.

IMPORTANT

If you are using the Allen-Bradley system sizing program, the average speed and average torque data has already been calculated and can be used in the above equation. If you are not sure of the exact speed and torque in your application, another approach is to look at the speed/torque curve for your Ultra5000/motor combination and use the values for the worst case continuous speed and torque.

IMPORTANT

Calculations are multiplied by a factor to compensate for the power and loss elements within a power system. A factor of 2.0 is used with a single phase system and a factor of 1.5 is used with a three phase system. This factor should minimize the effects of the secondary line voltage sagging in the transformer during peak current periods.

Example: sizing a transformer to the voltage requirements of an 2098-IPD-020 and MPL-A320P motor:

$$KVA = \frac{Speed(RPM) \times Torque(lb-in)}{63,025} \times \frac{746Watts}{HP} \times \frac{KVA}{1000Watts} \times 2.0$$

$$KVA = \frac{5,000(RPM) \times 26(lb-in)}{42,250}$$

$$Transformer\ Size = 3.1KVA$$

The speed/torque curve information is based upon an Ultra5000 input voltage of 230 VAC. For a 115 VAC input voltage, the maximum speed can be reduced up to one half.

Bonding Your System

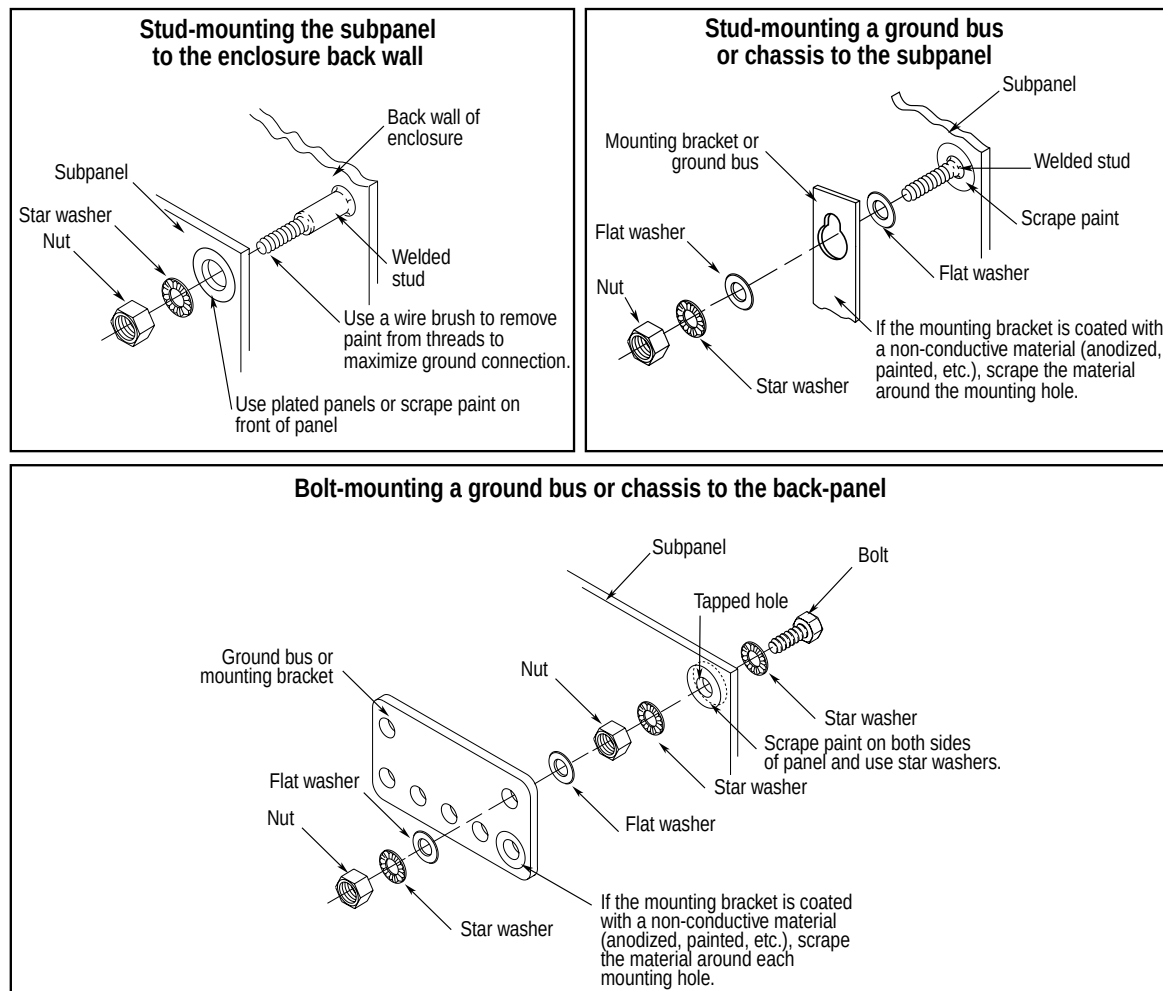
Bonding is the practice of connecting metal chassis, assemblies, frames, shields and enclosures to reduce the effects of electromagnetic interference (EMI).

Bonding Modules

Unless specified, most paints are not conductive, and they act as insulators. To achieve a good bond between modules and the subpanel, surfaces need to be paint-free or plated. Bonding metal surfaces creates a low-impedance exit path for high-frequency energy.

Improper bonding blocks that direct exit path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can effect the operation of other microprocessor controlled equipment. The illustrations that follow (refer to Figure 1.2) show details of recommended bonding practices for painted panels, enclosures, and mounting brackets.

Figure 1.2
Recommended Bonding Practices



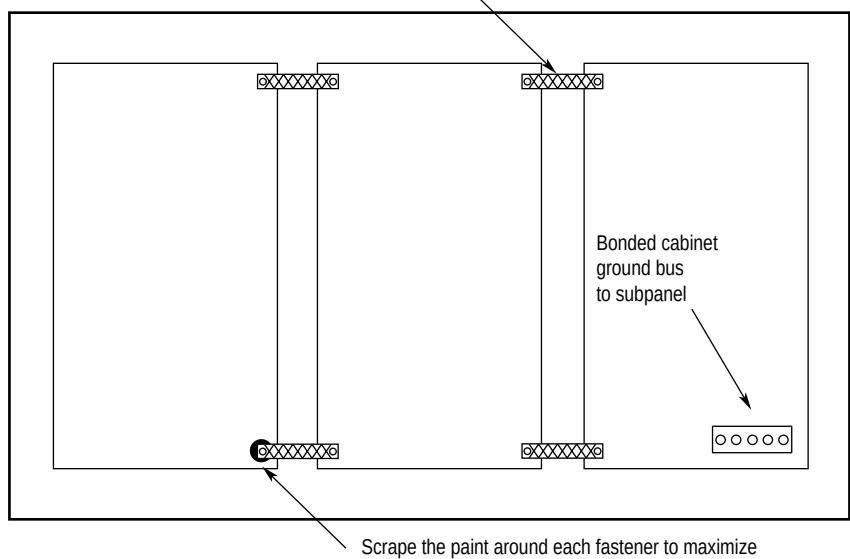
Bonding Multiple Subpanels

Bonding multiple subpanels creates a common low impedance exit path for the high frequency energy inside the cabinet. Subpanels that are not bonded together may not share a common low impedance path. This difference in impedance may affect networks and other devices that span multiple panels. Refer to the figure below for recommended bonding practices.

Figure 1.3
Multiple Subpanels and Cabinet

Recommended:

Bond the top and bottom of each subpanel to the cabinet using 25.4 mm (1.0 in.) by 6.35 mm (.25 in.) (minimum) wire braid



Mounting Your Ultra5000 Drive

The procedures in this section assume you have prepared your panel and understand how to bond your system. For installation instructions regarding other equipment and accessories, refer to the instructions that came with each of the accessories for their specific requirements.

To mount your Ultra5000 drive:

1. Layout the positions for the Ultra5000 and accessories in the enclosure. Mounting hole dimensions for the Ultra5000 are shown in *Appendix A*.
2. Attach the Ultra5000 to the cabinet, first using the upper mounting slots of the drive and then the lower. The recommended mounting hardware is M5 metric (1/4-20) or #10 MS bolts. Observe bonding techniques as described in *Bonding Your System*.
3. Tighten all mounting fasteners.

Connecting Your Ultra5000

Chapter Objectives

This chapter describes how to make wiring and cable connections for your Ultra5000. This chapter includes:

- Understanding Ultra5000 connectors
- Understanding Ultra5000 I/O specifications
- Understanding encoder feedback specifications
- Understanding serial interfaces
- Understanding basic wiring requirements
- Grounding your Ultra5000
- Wiring your Ultra5000

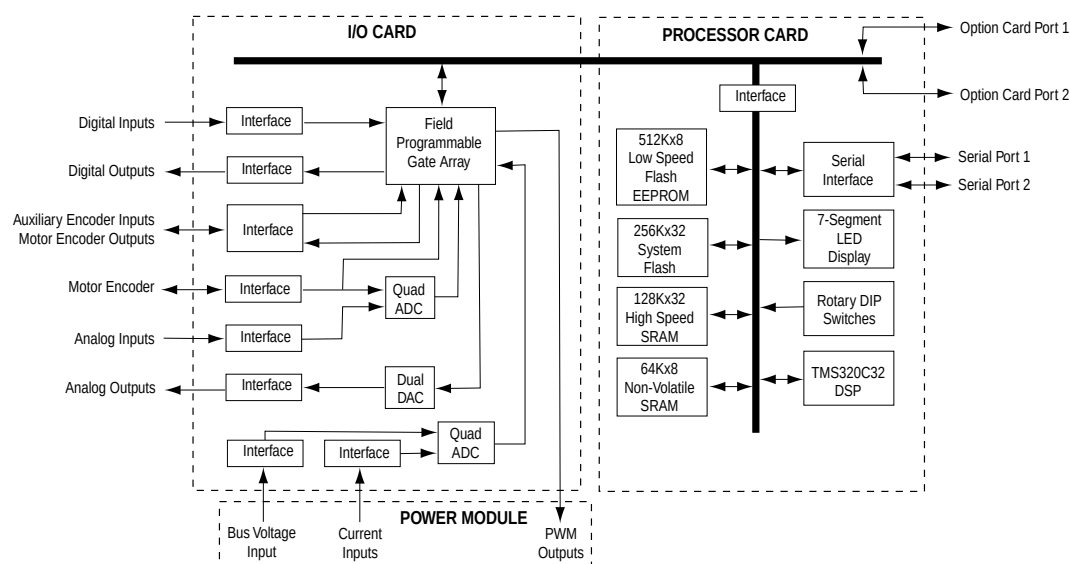
Understanding Ultra5000 Connectors

This section provides an overview of the Ultra5000 front panel connectors.

Ultra5000 Block Diagram

The Ultra5000 uses a two-stage circuit card solution with the capability of adding two additional option cards. The first stage is the processor circuit board and the second stage handles I/O connections including a power module interface, as shown in Figure 2.1.

Figure 2.1
Block Diagram of Ultra5000 Controller Functions



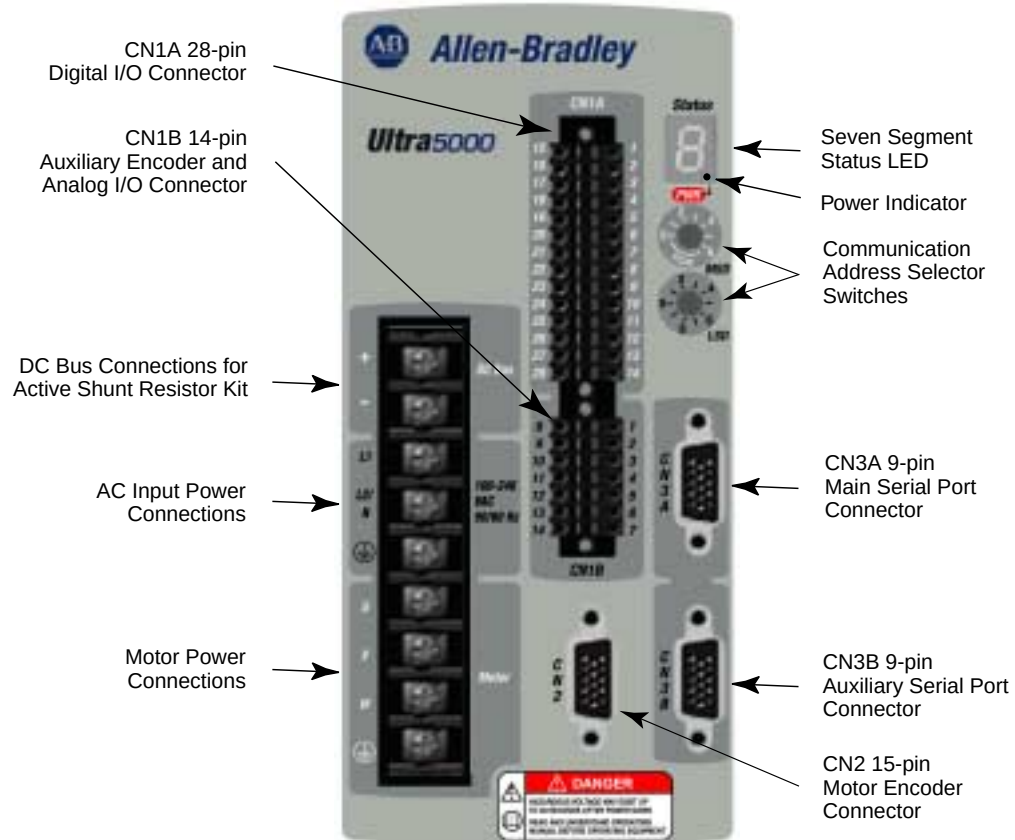
Front Panel Connections

The following table provides a brief description of the Ultra5000 front panel connectors and describes the connector type.

Designator	Description	Connector
CN1A	User Input/Output	28-Pin, 3.5mm, double-row, plugable spring clamp
CN1B	User Input/Output	14-Pin, 3.5mm, double-row, plugable spring clamp
CN2	Motor Encoder	15-Pin, high-density D-shell
CN3A	Main Serial Port 1	9-Pin, standard D-shell
CN3B	Auxiliary Serial Port 2	9-Pin, standard D-shell
TB	DC bus, Motor and AC power	9 position screw style barrier terminal strip

All connections on the Ultra5000 that require shielding use commonly available D-Shell type connectors. To locate the Ultra5000 front panel connectors, switches, and status LED, refer to the figure below.

Figure 2.2
Ultra5000 Front Panel Connections



I/O Connectors

CN1A (28-pin) and CN1B (14-pin) are plugable, double-row, spring clamp connectors with 3.5mm spacing and are included with your Ultra5000.

The following table provides the signal description and pin-outs for the CN1A I/O connector.

Signal	Description	CN1A Pin	Signal	Description	CN1A Pin
INPUT1	Digital Input 1	1	INPUT9	Digital Input 9	15
INPUT2	Digital Input 2	2	INPUT10	Digital Input 10	16
INPUT3	Digital Input 3	3	INPUT11	Digital Input 11	17
INPUT4	Digital Input 4	4	INPUT12	Digital Input 12	18
INPUT5	Digital Input 5	5	INPUT13	Digital Input 13	19
INPUT6	Digital Input 6	6	INPUT14	Digital Input 14	20
INPUT7	Digital Input 7	7	INPUT15	Digital Input 15	21
INPUT8	Digital Input 8	8	INPUT16	Digital Input 16	22
OUTPUT1	Digital Output 1	9	OUTPUT5	Digital Output 5	23
OUTPUT2	Digital Output 2	10	OUTPUT6	Digital Output 6	24
OUTPUT3	Digital Output 3	11	OUTPUT7	Digital Output 7	25
OUTPUT4	Digital Output 4	12	OUTPUT8+	Relay Output 8+	26
SHIELD	Shield Termination	13	OUTPUT8-	Relay Output 8-	27
IOPWR	I/O Power Supply	14	IOCOM	I/O Ground	28

The following table provides the signal description and pin-outs for the CN1B I/O connector.

Signal	Description	CN1B Pin	Signal	Description	CN1B Pin
+5V	5v Power Supply	1	+5VCOM	5v Ground	8
AX+	Auxiliary Encoder Input / Output A+	2	AIN1	Analog Input 1	9
AX-	Auxiliary Encoder Input / Output A-	3	AIN2	Analog Input 2	10
BX+	Auxiliary Encoder Input / Output B+	4	+5VCOM	5v Ground	11
BX-	Auxiliary Encoder Input / Output B-	5	AOUT1	Analog Output 1	12
IX+	Auxiliary Encoder Input / Output I+	6	AOUT2	Analog Output 2	13
IX-	Auxiliary Encoder Input / Output I-	7	SHIELD	Shield Termination	14

Motor Encoder Connector

CN2 is a 15-pin high-density D-shell connector used for connection to the motor encoder. The following table provides the signal description and pin-outs for the CN2 motor encoder connector.

Signal	Description	CN2 Pin	Signal	Description	CN2 Pin
A+	Motor Encoder Channel A+	1	+Limit	+Limit	9
A-	Motor Encoder Channel A-	2	I- / DATA-	Motor Encoder Channel Index/Data-	10
B+	Motor Encoder Channel B+	3	TS	Thermostat	11
B-	Motor Encoder Channel B-	4	S1	Hall Channel 1	12
I+ / DATA+	Motor Encoder Channel Index/Data+	5	S2	Hall Channel 2	13
ECOM	Encoder Common	6	EPWR	Encoder Power (+5v only)	14
—	Reserved	7	-Limit	-Limit	15
S3	Hall Channel 3	8			

Serial Port Connectors

CN3A and CN3B are 9-pin serial port connectors. The following table provides the signal description and pin-outs for the CN3A and CN3B serial port connectors.

Signal	Description	CN3A and CN3B Pins	Signal	Description	CN3A and CN3B Pins
RCV+	RS-422/RS-485 Input+	1	—	Not Connected	6
RCV	RS-232 Input	2	RCV-	RS-422/RS-485 Input-	7
XMT	RS-232 Output	3	XMT-	RS-422/RS-485 Output-	8
XMT+	RS-422/RS-485 Output+	4	—	Not Connected	9
DGND	Logic Ground	5			

Understanding Ultra5000 I/O Specifications

A description of the Ultra5000 input/output specifications is provided on the following pages.

Digital Inputs

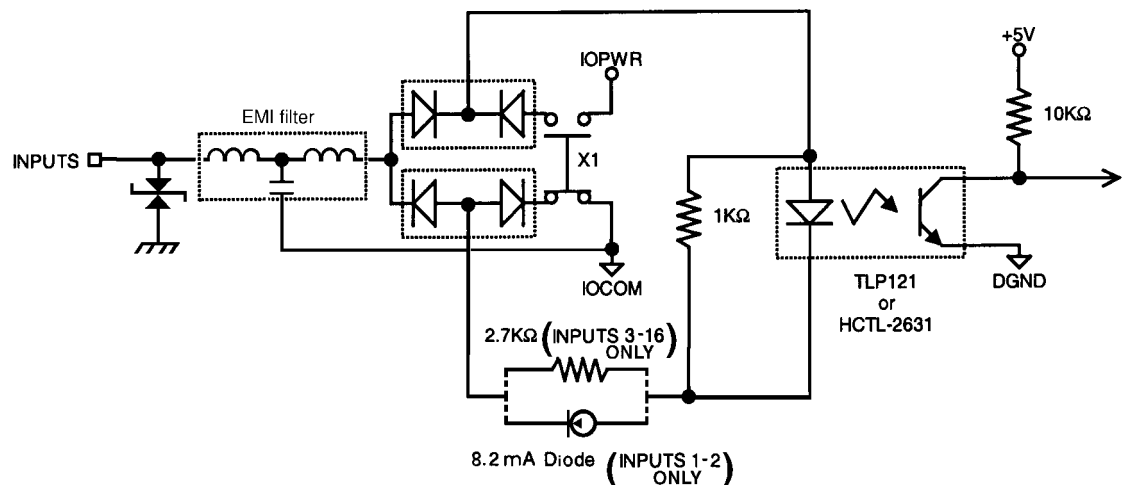
There are 16 general purpose digital inputs to use as needed. They are not connected in hardware to perform a particular function.

IMPORTANT

Configure your digital inputs (as a group) as active high (current sinking) or active low (current sourcing).

All digital inputs have the same configuration. Inputs 1 and 2 use high-speed circuitry, with minimal propagation delays, suitable for use in registration applications. Any input can be assigned through firmware to latch the motor or auxiliary position in hardware (refer to Figure 2.3).

Figure 2.3
Digital Input Hardware Configuration



Note: X1 is controlled through software to be "up" for active low and "down" for active high.

The following table provides a description of the digital input specifications.

Parameter	Description	Minimum	Maximum
ON State Voltage, Active High Configuration	Voltage applied to the input, with respect to IOCOM, to guarantee an ON state.	10.8 V	26.4 V
ON State Voltage, Active Low Configuration	Voltage applied to the input, with respect to IOPWR, to guarantee an ON state.	-26.4 V	-10.8 V
ON State Current	Current flow to guarantee an ON State	3.0 mA	12.0 mA
OFF State Voltage, Active High Configuration	Voltage applied to the input, with respect to IOCOM, to guarantee an OFF state.	-1.0 V	3.0 V
OFF State Voltage, Active Low Configuration	Voltage applied to the input, with respect to IOPWR, to guarantee an OFF state.	-3.0 V	1.0 V
Propagation Delay, High Speed Inputs	Signal propagation delay from the high speed digital input to the firmware accessible registers, active high or active low, turning ON or turning OFF.	—	0.5 μ S
Propagation Delay, Low Speed Inputs	Signal propagation delay from the low speed digital input to the firmware-accessible registers, active high or active low, turning ON or turning OFF.	—	100 μ S

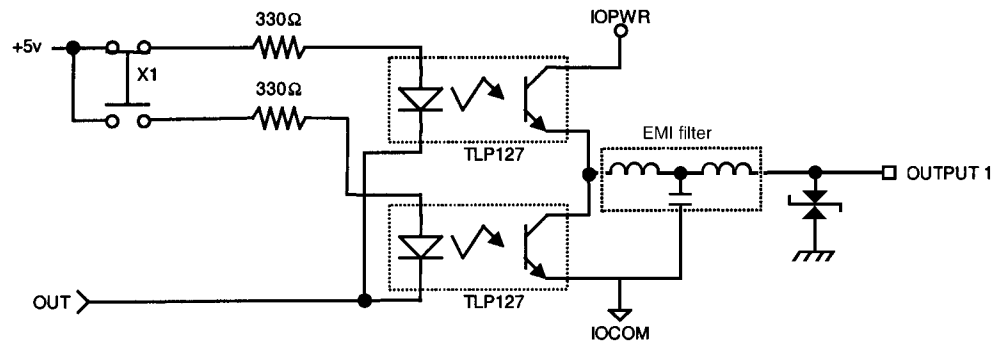
Digital Outputs

There are eight general purpose digital outputs to use as needed. They are not connected in hardware to perform any function. Digital outputs (Outputs 1-7) are transistor outputs, as shown in Figure 2.4. Output 8 is a normally open relay output.

IMPORTANT

There is no output short circuit protection on the transistor outputs. To some degree, the bipolar transistors limit their own current output, but they have not been designed to specifically protect against shorts to power or ground.

Figure 2.4
Transistor Output Hardware Configuration



Note: X1 is controlled through software to be “up” for active high and “down” for active low.

The following table provides a description of the digital (transistor) output specifications.

Parameter	Description	Minimum	Maximum
ON State Current	Current flow when the output transistor is ON	—	50 mA
OFF State Current	Current flow when the output transistor is OFF	—	0.1 mA
ON State Voltage	Voltage across the output transistor when ON	—	1.5 V
OFF State Voltage	Voltage across the output transistor when OFF	—	50 V

The following table provides a description of the digital (relay) output specifications.

Parameter	Description	Minimum	Maximum
ON State Current	Current flow when the relay is closed	—	1 A
ON State Resistance	Contact resistance when the relay is closed	—	1 Ω
OFF State Voltage	Voltage across the contacts when the relay is open	—	30 V
OFF State Current	Current flow when the relay is open	—	0.01 mA

Analog Inputs

There are two single-ended general purpose analog inputs to use as needed. A 12-bit sampling A/D converter generates the digital representation of the analog inputs. The following table provides a description of the analog input specifications.

Parameter	Description	Minimum	Maximum
Resolution	Number of states that the input signal is divided into which is $2^{(\text{to the number of bits})}$.	12 Bits	—
Input Impedance	Open circuit impedance measured between the input and analog common.	10 k Ω	—
Input Signal Range	Voltage applied to the input - Usable	-10 V	+10 V
	Voltage applied to the input - Limit	- 14 V	+ 14 V
Offset Error	Deviation from the correct value expected from analog-to-digital conversion when 0 V is applied to the input.	—	50 mV
Gain Error	Deviation of the transfer function from unity gain, expressed in a percent of full scale.	—	1%
Propagation Delay	Delay from the input to the firmware-accessible registers.	—	100 μ S

Analog Outputs

There are two single-ended general purpose analog outputs to use as needed. A 12-bit D/A converter generates an analog representation of the digital command value. The two analog outputs are set to zero volts after power comes up. The following table provides a description of the analog output specifications.

IMPORTANT

Output values can vary during power-up until the specified power supply voltage is reached.

Parameter	Description	Minimum	Maximum
Resolution	Number of states that the output signal is divided into, which is $2^{(\text{to the number of bits})}$.	12 Bits	—
Output Current	Current capability of the output.	-2 mA	+2 mA
Output Signal Range	Range of the output voltage.	-10 V	+10 V
Offset Error	Deviation when the output should be at 0V.	—	50 mV
Gain Error	Deviation of the transfer function from unity gain, expressed in a percent of full scale.	—	1%

Understanding Encoder Feedback Specifications

The Ultra5000 offers two motor feedback interfaces. A description of the Ultra5000 encoder feedback specifications is provided starting below.

Encoder Interface

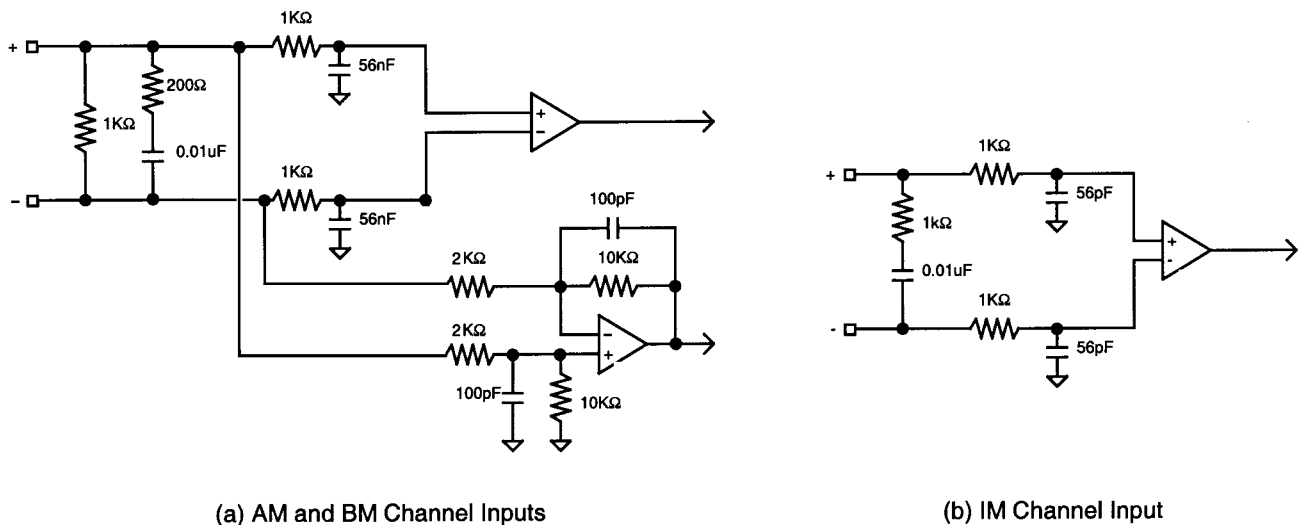
The Ultra5000 main encoder feedback connector is CN2. The motor encoder interface circuitry features include:

- 2.5 MHz maximum line frequency
- RS-485 serial channel for communicating with intelligent encoders
- Hall input for start-up commutation only
- Interpolation of sine/cosine encoders

All encoder signals are filtered using analog and digital filtering. The inputs also include illegal state change detection. Refer to Figure 2.5 for a schematic of the motor encoder inputs.

Hardware latches can be used for latching the encoder position based on an index input or a digital input transition.

Figure 2.5
Schematic of the Motor Encoder Inputs



The following table provides a description of the motor encoder interface specifications.

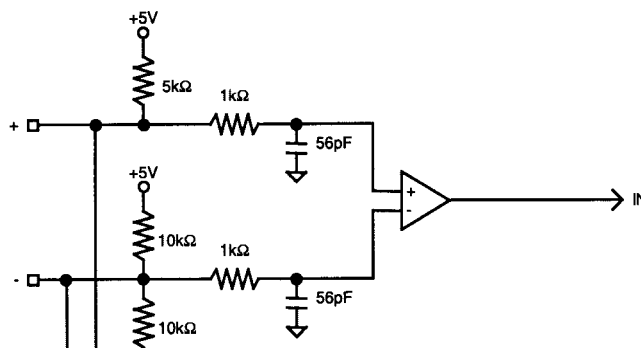
Parameter	Description	Minimum	Maximum
AM, BM, and IM ON State Input Voltage	Input voltage difference between the + input and the - input that is detected as an ON state.	+1.0 V	+12.0 V
AM, BM, and IM OFF State Input Voltage	Input voltage difference between the + input and the - input that is detected as an OFF state.	-1.0 V	-12.0 V
Common Mode Input Voltage	Potential difference between any encoder signal and logic ground.	-7.0 V	+12.0 V
DC Current Draw	Current draw into the + or - input.	-30 mA	30 mA
AM, BM Input Signal Frequency	Frequency of the AM or BM signal inputs. The count frequency is 4 times this frequency, since the circuitry counts all four transitions.	—	2.5 MHz
IM Pulse Width	Pulse width of the index input signal. Since the index is active for a percentage of a revolution, the speed will determine the pulse width.	125 nS	
AM / BM Phase Error, 2.5 MHz Line Frequency	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-22.5°	+22.5°
AM / BM Phase Error, 1 MHz Line Frequency	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-45°	+45°
AM and BM Input Voltage, Sine/Cosine Interpolation	Peak-to-peak input voltages of the AM and BM inputs for high resolution interpolation.	0.9 V (p-p)	1.1 V (p-p)

Auxiliary Encoder Interface

All encoder input signals (CN1B) are filtered using analog and digital filtering, including illegal state change detection.

The input circuitry includes pull-up and pull-down resistors for compatibility with single-ended and open collector signals, in addition to differential signals. A single channel schematic of the auxiliary encoder interface is shown in the figure below.

Figure 2.6
Schematic of the Auxiliary Encoder Circuitry



The following table provides a description of the auxiliary encoder interface specifications.

Parameter	Description	Minimum	Maximum
ON State Input Voltage	Input voltage difference between the + input and the - input that is detected as an ON state.	+1.0 V	+12.0 V
OFF State Input Voltage	Input voltage difference between the + input and the - input that is detected as an OFF state.	-1.0 V	-12.0 V
Common Mode Input Voltage	Potential difference between any encoder signal and logic ground.	-7.0 V	+12.0 V
DC Current Draw	Current draw into the + or - input.	-5 mA	5 mA
Input Signal Frequency	Frequency of the AX or BX signal inputs. In A/B/I mode, the count frequency is 4 times this frequency, since the circuitry counts all four transitions of these lines. In Step/Direction or CW/CCW mode, the count frequency is the same as the signal frequency.	—	2.5 MHz
IX Pulse Width, A/B/I Mode	Pulse width of the index input signal. Since the index is active for a percentage of a revolution, the speed will determine the pulse width.	125 nS	—
AX / BX Phase Error, 2.5 MHz Line Frequency, A/B/I Mode	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-22.5°	+22.5°
AX / BX Phase Error, 1 MHz Line Frequency, A/B/I Mode	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-45°	+45°

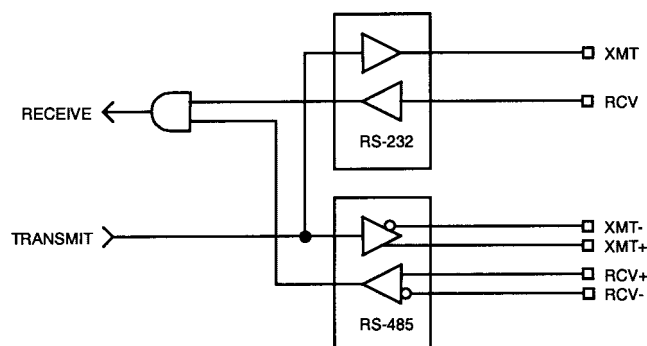
Understanding Serial Interfaces

The Ultra5000 contains two identical serial port connectors (Main Serial Port CN3A and Auxiliary Serial Port CN3B) that implement the standard NRZ asynchronous serial format, and support RS-232, RS-422, and RS-485 communication standards.

Standard baud rates include 1,200, 2,400, 4,800, 9,600, 19,200, and 38,400 baud. Data lengths of 7 and 8 bits are supported.

The connector pinout dedicates separate pins for the RS-232 and RS-422 / RS-485 signals, so that the communication standard can be changed by just using a different cable. Refer to Figure 2.7 for the serial interface hardware configuration.

Figure 2.7
Serial Interface Hardware Configuration



Understanding Basic Wiring Requirements

This section contains basic wiring information for the Ultra5000.

ATTENTION

Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

IMPORTANT

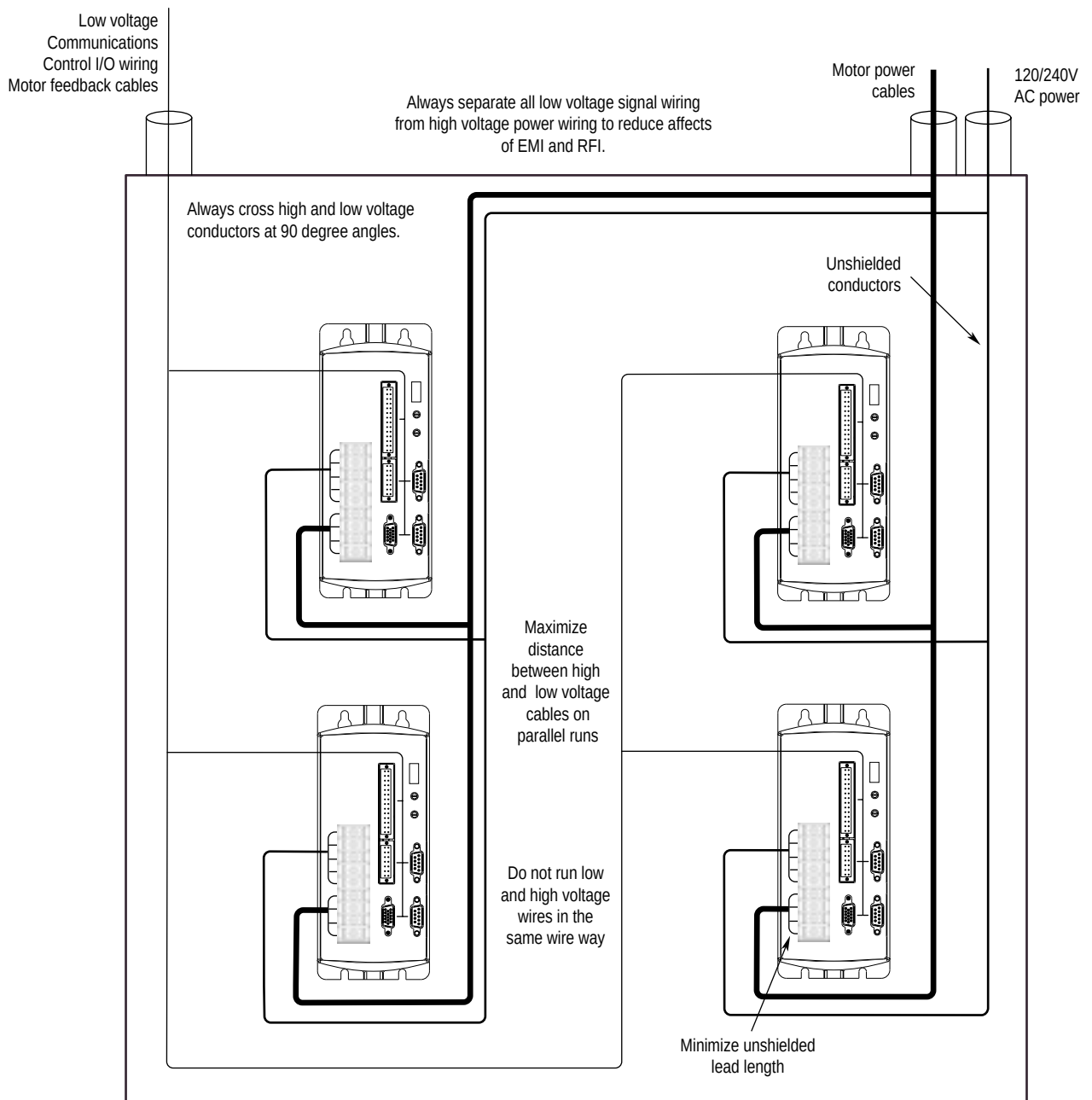
This section contains common PWM servo system wiring configurations, size, and practices that can be used in a majority of applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

For emergency stop (E-stop) wiring information, refer to *Appendix C*.

Routing High and Low Voltage Cables

Be aware that when you connect and route power and signal wiring on a machine or system, radiated noise from nearby relays (relay coils should have surge suppressors), transformers, and other electronic drives can be induced into motor or encoder feedback, communications, or other sensitive, low voltage signals. This can cause system faults and communication problems. To minimize the levels of radiated noise, route machine power and signal lines separately.

Figure 2.8
Routing Cables Inside Your Cabinet



Grounding Your Ultra5000

We recommend that all equipment and components of a machine or process system have a common earth ground point connected to their chassis. A grounded system provides a safety ground path for short circuit protection. Grounding your modules and panels minimizes shock hazards to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis. For CE grounding requirements, refer to *Appendix C*.

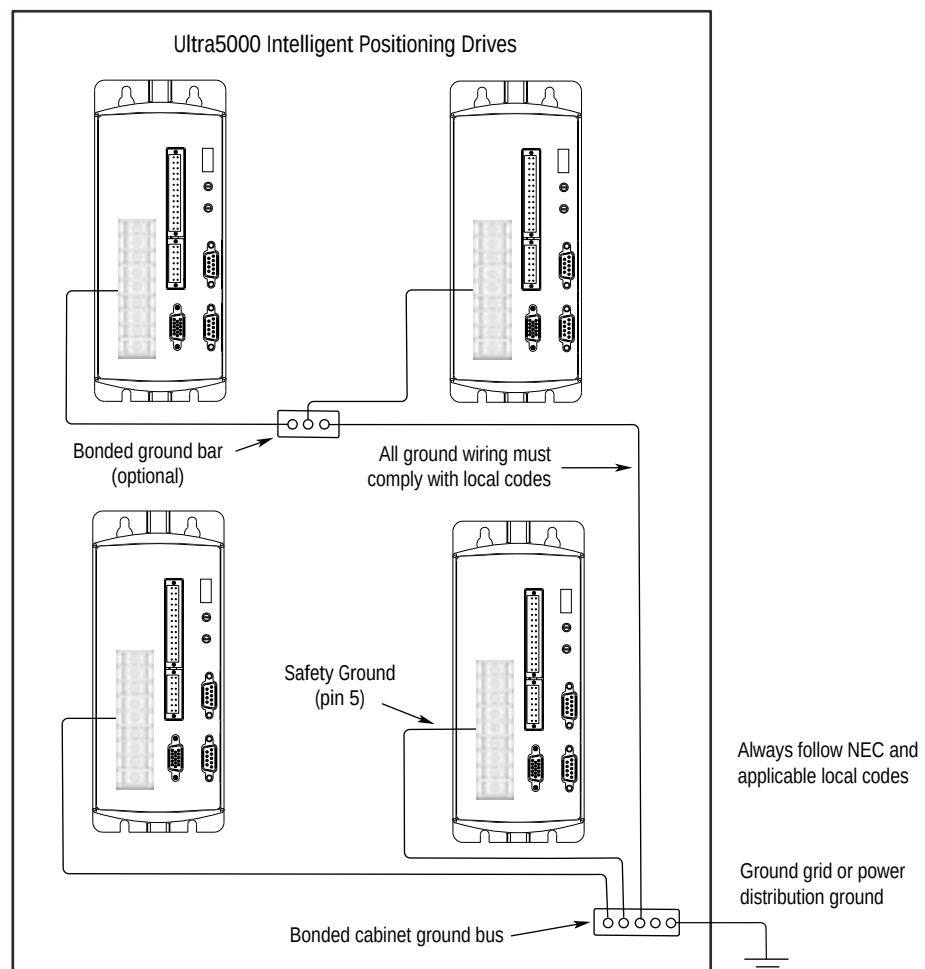
Grounding Your System to the Subpanel

ATTENTION



The National Electrical Code contains grounding requirements, conventions, and definitions. Follow all applicable local codes and regulations to safely ground your system. Refer to the illustration below for details on grounding your Ultra5000. Refer to Figure 2.15 for the power wiring diagram.

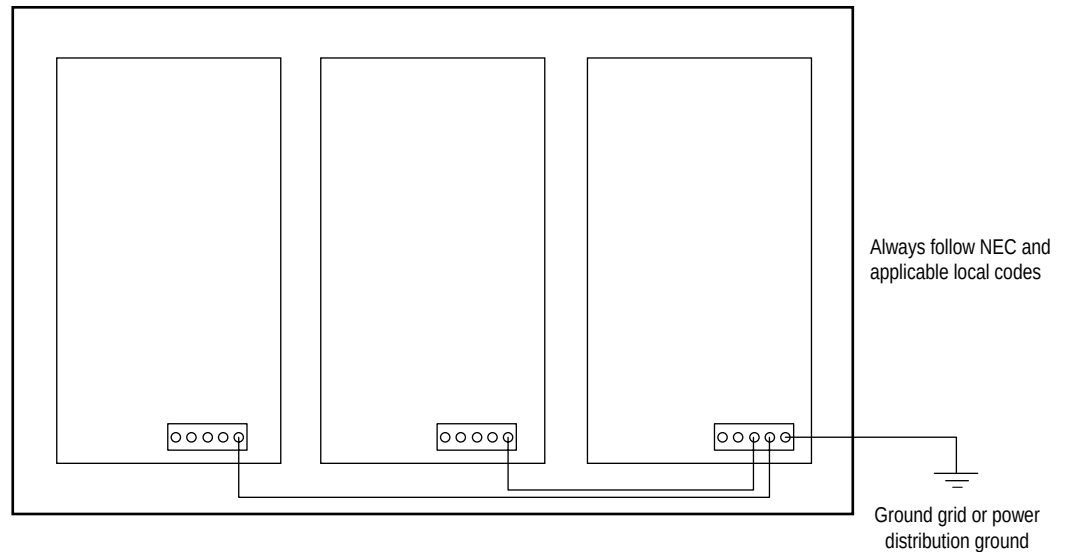
Figure 2.9
Safety Ground Configuration with Multiple Ultra5000 Systems on One Panel



Grounding Multiple Subpanels

To ground multiple subpanels, refer to the figure below.

Figure 2.10
Subpanels Connected to a Single Ground Point



EMC Motor Ground Termination

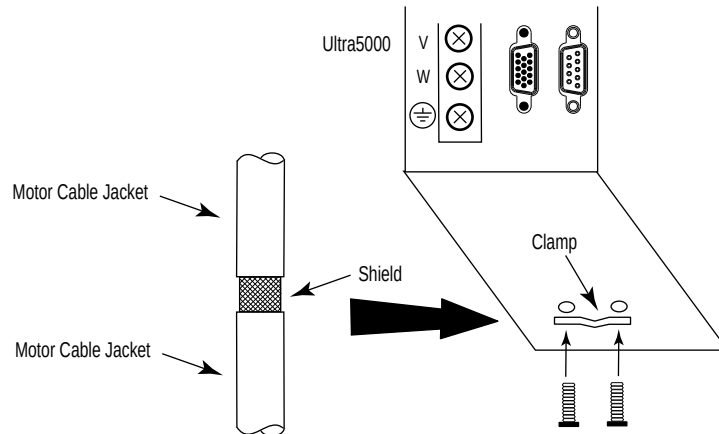
For F-Series, H-Series, and N-Series motors the factory supplied power cables are shielded. The power cable is designed to be terminated at the drive during installation. A small portion of the cable jacket is removed which exposes the shield braid. The exposed area must be clamped to the bottom of the drive chassis using the clamp provided. Refer to Figure 2.11 for an illustration.

ATTENTION

To avoid hazard of electrical shock, ensure shielded power cables are grounded at a minimum of one point for safety.

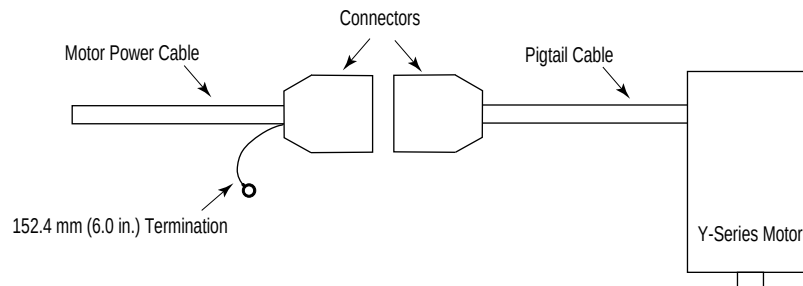


Figure 2.11
Motor Cable EMC Shield Connection



Y-Series motors have a short pigtail cable which connects to the motor, but is not shielded. These motor power cables have a 152.4 mm (6.0 in.) shield termination wire with a ring lug that connects to the closest earth ground. The termination wire may be extended to the full length of the motor pigtail if necessary, but it is best to connect the supplied wire directly to ground without lengthening. Refer to Figure 2.12 for an illustration.

Figure 2.12
Y-Series Motor Cable EMC Connection



Wiring Your Ultra5000

These procedures assume you have bonded and mounted your Ultra5000 to the subpanel and that there is no power applied to the system.

ATTENTION



This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD Protection Handbook.

The following sections provide information and procedures on how to wire your Ultra5000.

Connecting Interface Cables

Connect all interface cables as shown in the table below.

This cable:	Plugs into this connector:
28-pin, Digital I/O	CN1A
14-pin, Auxiliary encoder/analog I/O	CN1B
15-pin, Motor encoder feedback	CN2
9-pin, Main serial port	CN3A
9-pin, Auxiliary serial port	CN3B

Wiring I/O Connections

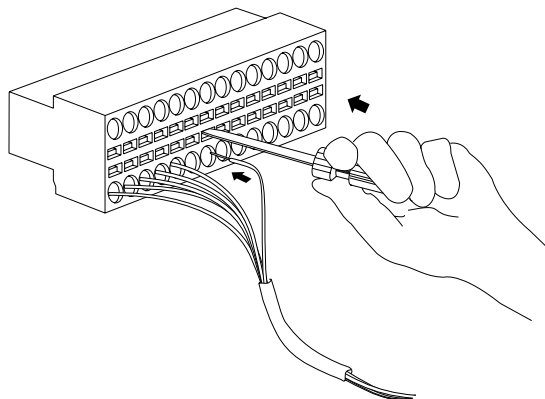
To wire your CN1A and CN1B I/O connectors:

1. Prepare your I/O wires by stripping approximately 6 mm (0.25 in.) of insulation from the end.

Note: Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

2. Using the small blade type screw driver supplied with your Ultra5000 (part number 9111-0031) depress the spring clamp next to the pin you're prepared to wire and insert the wire, as shown in Figure 2.13.

Figure 2.13
Inserting Wires into the Connector Housing



3. Remove the screw driver and gently pull on the wire to make sure it does not come out of its terminal. Re-insert and test any loose wires.

Wiring Power Connections

The Ultra5000 requires single phase AC power, 100 to 240 VAC. The input power may be optionally isolated through a transformer. Field wiring must be copper, with 75°C (194°F) minimum rating. The phasing of L1 and L2/ N is arbitrary. The earth ground connection is required for safe and proper system operation. Terminal block connections should be torqued to 1.25 Nm (11 lb-in.). Refer to Figure 2.15 for a power wiring diagram.

The Motor Encoder and Auxiliary Encoder ports are powered by a single internal power supply. The power supply has a resettable fuse that opens at 3 amps and automatically resets itself when the current falls below 3 amps. There are no internal fuses requiring replacement.

The Ultra5000 utilizes solid state motor overload protection which operates in accordance with UL 508C.

Motor overload protection trips:	At:
Eventually	100% overload
Within 8 minutes	200% overload
Within 20 seconds	600% overload

ATTENTION



To avoid personal injury and/or equipment damage, ensure installation complies with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment.

To avoid personal injury and/or equipment damage, ensure motor power connectors are used for connection purposes only. Do not use them to turn the unit on and off.

To avoid personal injury and/or equipment damage, ensure shielded power cables are grounded to prevent potentially high voltages on the shield.

To wire your input power and motor connections:

1.

Prepare your wires for connection to the terminal block by stripping approximately 12 mm (0.50 in.) of insulation from the end.
- Note:

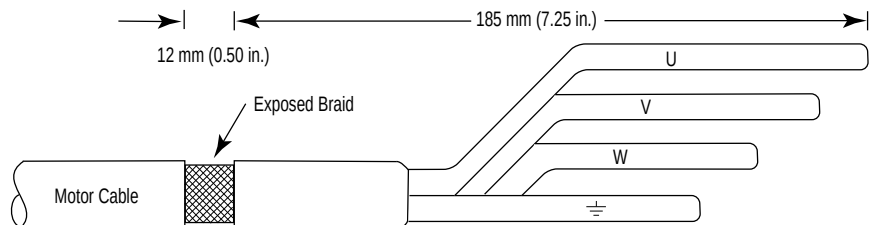
Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

- Check for continuity in the motor leads (wires marked U, V, and W). Verify that the resistance reading from each wire to earth ground is above 500k ohms.

If your resistance reading is:	Then:
Above 500k ohms	Go to main step 3.
Below 500k ohms	Go to the chapter <i>Maintaining Your Ultra5000</i> .

- Prepare your motor cable for the CE clamp on the bottom of the Ultra5000 drive by removing 12 mm (0.50 in.) of insulation 185 mm (7.25 in.) from the end of the motor leads (wires marked U, V, and W). Refer to the figure below for an illustration.

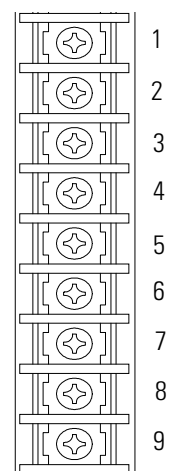
Figure 2.14
CE Clamp Cable Preparation



- Using a screw driver, loosen the screw for each of the terminal locations and attach wires as shown in the table below. Refer to Figure 2.2 for the location of the terminal block. Refer to Figure 2.15 for the Ultra5000 power wiring diagram.

Insert the wire labeled:	Into this terminal block position:
DC bus + ¹	1
DC bus - ¹	2
L1 (Line 1)	3
L2 (Line 2)/ N (Neutral)	4
Safety (earth) ground	5
U ²	6
V ²	7
W ²	8
Motor case ground	9

Terminal Block
Pin-out



¹ Do not connect an external I/O power supply to the DC bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

² Ensure motor power is wired with proper phasing relative to the motor terminals.

5. Tighten each screw with a torque of 1.25 Nm (11 lb-in.).
6. Gently pull on each wire to make sure it does not come out of its terminal. Re-insert and tighten any loose wires.
- 7.

If your motor is:	Then:
F-Series, H-Series, or N-Series	Go to <i>Connecting F-Series, H-Series, and N-Series EMC Cable Shield</i>
Y-Series	Go to <i>Connecting Y-Series EMC Cable Shield</i>

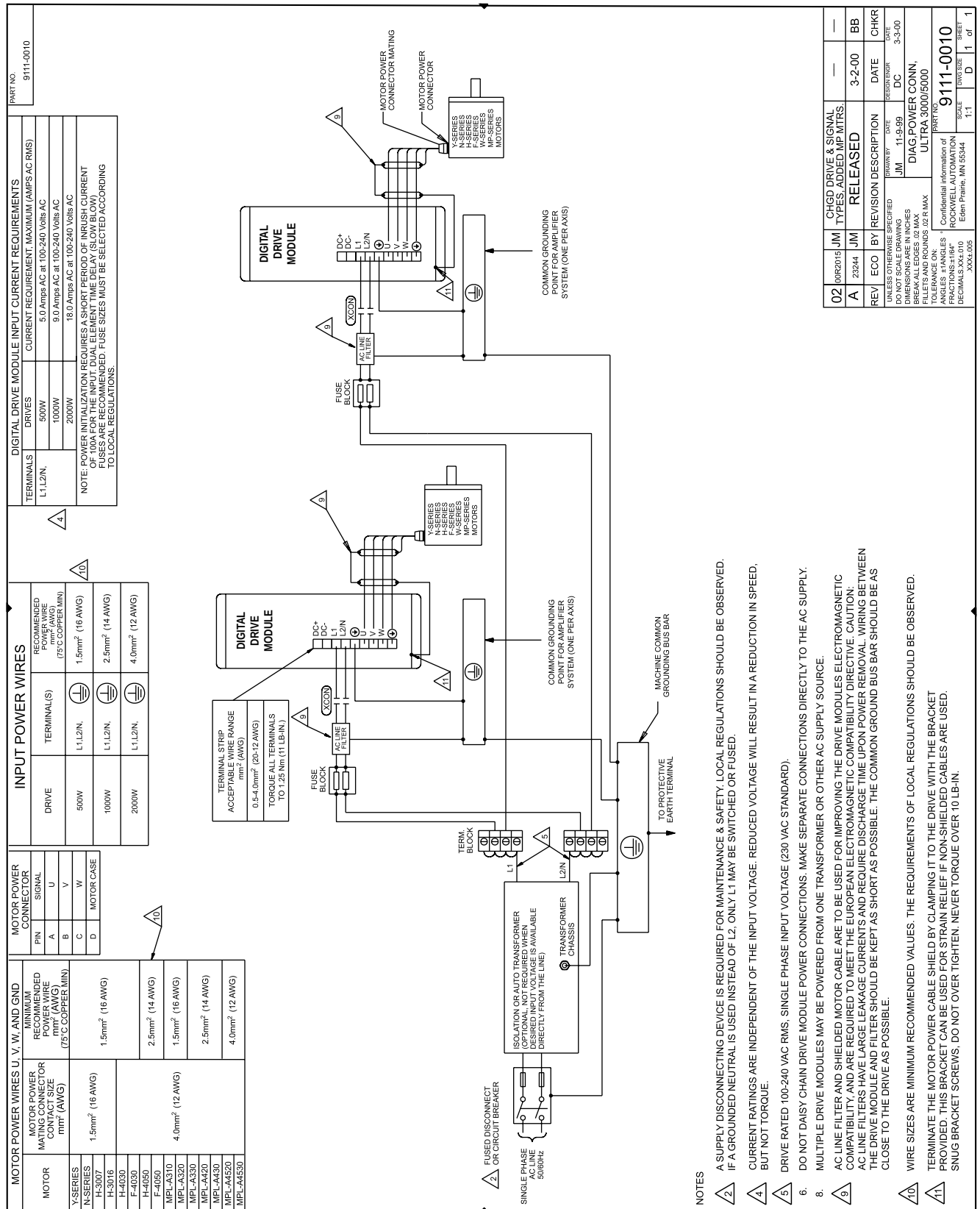
Connecting F-Series, H-Series, and N-Series EMC Cable Shield

1. Remove the two screws securing the cable clamp on the bottom of the Ultra5000 drive (refer to Figure 2.11 for cable clamp location).
2. Place the cable within the clamp and replace the screws (do not tighten).
3. Position the exposed portion of the cable braid directly in line with the clamp.
4. Tighten the screws with a torque of 0.9-1.1 Nm (8.0-10.0 lb-in.).

Connecting Y-Series EMC Cable Shield

Connect the 152.4 mm (6.0 in.) termination wire to the closest earth ground (refer to Figure 2.12 for pigtail location).

Figure 2.15
Ultra5000 Power Wiring Diagram



Commissioning Your Ultra5000

Chapter Objectives

This chapter provides you with information to power up and start your Ultra5000. This chapter includes:

- General startup precautions
- Understanding communication switch settings
- Applying power to your system
- Configuring your Ultra5000

Before you begin these procedures, be sure to read and understand the information in the previous chapters of this manual.

Note: The procedures in this chapter do not include information regarding integration with other products.

General Startup Precautions

The following precautions pertain to all of the procedures in this chapter. Be sure to read and thoroughly understand them before proceeding.

ATTENTION



This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltages on the system bus network have been discharged before attempting to service, repair or remove this unit. Only qualified personnel familiar with solid state control equipment and safety procedures in publication NFPA 70E or applicable local codes should attempt this procedure.

ATTENTION



This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD Protection Handbook.

Understanding Communication Switch Settings

The Ultra5000 communication address selector switches (MSD and LSD) allow setting a unique address for each Ultra5000 connected on a serial network. The switches allow setting addresses 0-99. Refer to Figure 2.2 for the switch locations. Addresses are reserved for use as shown in the table below.

Switch Settings:	Description:
0-63	Valid settings for normal drive operation
64-95	Reserved for factory use only
96	Disable Program Auto Run mode. With this setting during power-up, programs are not allowed to run. This mode is useful to correct programming problems that may have caused communications loss when the program is running.
97	Set Factory Default Objects mode. With this setting during power-up, all internal firmware objects are reset to factory defaults. Any objects created by a user program is also reset. This mode is useful to return a drive to factory defaults.
98	Reserved for factory use only
99	Boot mode. With this setting during power-up, the only action that may be performed is to upgrade the drive firmware using Ultraware.

Applying Power To Your System

This procedure assumes you have wired your Ultra5000 system, verified the wiring, and are ready to begin using your Ultraware software. To apply power to your Ultra5000 system:

1. Disconnect any load to the motor. Ensure the motor is free of all linkages when initially applying power to the system.
2. Verify the input supply voltage. The Ultra5000 requires single phase, 100-240V AC rms power with an input frequency of 47-63 Hz.

If the input power is:	Then:
Within the acceptable range (100-240V AC)	Go to main step 3.
Not within the acceptable range	Stop and call for technical support. Do not proceed until proper input power is supplied. Once you have proper input power, proceed to main step 3.

- Set the communication address switches as shown in the example table below. For the location of the address switches, refer to Figure 2.2.

For example, if you have:	Set the MSD switch to:	Set the LSD switch to:
1 drive	0	1
2 drives	0	2
3 drives	0	3
4 drives	0	4

- Apply input power to the Ultra5000 and observe the power indicator LED on the Ultra5000 front panel (refer to Figure 2.2 for LED location).

If the power LED:	Then:
Is on	Go to main step 5.
Is not on	- Check your input power connections. - Repeat main step 4.

- Check the seven segment status LEDs.

If the seven segment status LEDs:	Then:
Actively cycle in a full circle	The drive is ready. Go to <i>Configuring Your Ultra5000</i> .
Actively cycle in a half circle with address switches set to MSD=9 and LSD=9	Go to main step 3 and reset your address switches according to the table.
Actively cycle in a half circle with address switches set according to the table in step 3	Your firmware requires an upgrade. Go to <i>Configuring Your Ultra5000</i>
Display an E (indicates error)	Go to the chapter <i>Maintaining Your Ultra5000</i> .

Configuring Your Ultra5000

This procedure assumes you have applied power to your system. To configure your Ultra5000 system:

- Start your Ultraware software. Refer to the *Ultraware User Manual* (publication 2098-UM001A-EN-P) for information on starting the Ultraware software.
- Open a recently used file or create a new file. Ultraware will scan for on-line drives.

3. Click on the Stop Scanning button when your drive is detected or wait for the scanning to time out.
4. Look for the Ultra5k icon under the On-Line Drives tree. The Ultra5k icon indicates that your drive is detected.

If your Ultra5000 drive:	Then:
Is detected and listed under the On-Line Drives tree	The system is ready. Go to main step 5.
Is not detected	1. Go to the previous section, <i>Applying Power to Your System</i>, step 3, and verify your address switch settings. 2. Check your serial cable connections. 3. Go to main step 1 of this section.

5. Refer to step 5 in the previous section, *Applying Power to Your System*.

If you were told:	Then:
The drive is ready	Go to main step 6 below.
Your firmware requires an upgrade	1. Select File from the main menu bar. 2. Select Upgrade Firmware. 3. Go back to main step 1 and repeat procedure.

6. Refer to the *Ultraware User Manual* (publication 2098-UM001A-EN-P) for further configuration and tuning instructions. The software and hardware are communicating and you are ready to configure your Ultra5000.

Maintaining Your Ultra5000

Chapter Objectives

This chapter covers the following topics:

- Maintaining the drive
- Troubleshooting

Maintaining the Drive

The Ultra5000 Drive is designed to function with a minimum of maintenance.

ATTENTION



DC bus capacitors may retain hazardous voltages after input power has been removed, but will normally discharge in several seconds.

Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the warning on the front of the drive.

Failure to observe this precaution could result in severe bodily injury or loss of life.

Periodic Maintenance

Normally the only maintenance required is removal of superficial dust and dirt from the drive and a quick check of cabling insulation and connections.

Cleaning the Drive

To clean the drive, use an OSHA approved nozzle that provides compressed air under low pressure ≤ 20 kPa (30 psi) to blow the exterior surface and the vents clean.

Inspecting the Cables

Ensure input power is disconnected before touching cabling or connections:

- Visually inspect all cables for abrasion,
- D-shell connectors should be inspected for proper seating and signal continuity end-to-end.

Troubleshooting

The normal state of the 7-segment LED is to actively cycle its segments and show an illuminated decimal point that indicates +5 volts. Refer to the table below to identify problems, potential causes, and appropriate actions to take to resolve the problems. If problems persist after attempting to troubleshoot the system, please contact your Allen-Bradley representative for further assistance.

Error Codes

The following list of problematic symptoms (no error code shown) and problems with assigned error codes is designed to help you resolve problems. The 7-segment LED (located on the front of the drive) displays the error codes. An E will be displayed followed by flashing the two-digit error code one digit at a time. This is repeated until the problem is cleared.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
	Power (PWR) indicator not illuminated	No AC power.	Verify power (115/230V AC single phase) is applied to the Ultra5000.
		Internal power supply malfunction.	Call your Allen-Bradley representative.
	7-Segment LED not cycling	Firmware corrupt	Set node address to 99 and reload firmware
			Call your A-B representative
	Small LED segment cycling	Node address set to 99	Change node address
		Firmware corrupt	Set node address to 99 and reload firmware
	Motor jumps when first enabled	Motor encoder wiring error.	Check motor encoder wiring.
		Incorrect motor chosen.	Select the proper motor in Ultraware Software.
	Digital I/O not working correctly	I/O power supply disconnected.	Verify connections and I/O power source.
		Incorrectly configured for active high or active low.	Change configuration.
04	Motor Overtemperature	Motor thermostat trips due to: High motor ambient temperature, and/or Excessive RMS torque.	Operate within (not above) the continuous torque rating for the ambient temperature (40°C maximum). Lower ambient temperature, increase motor cooling.
05	IPM Fault	Motor cables shorted.	Verify continuity of motor power cable and connector.
		Motor winding shorted internally.	Check for short on U,V,W and Gnd windings of the motor.
		Ultra5000 temperature too high.	Check for clogged vents or defective fan. Ensure cooling is not restricted by insufficient space around the unit.
		Operation above continuous power rating.	Verify ambient temperature is not too high (above 60° C). Operate within the continuous power rating.
		Ultra5000 has a bad IPM, output short circuit, or overcurrent.	Replace Ultra5000.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
09	Bus Undervoltage	Low AC line/AC power input. 100V AC minimum for safe Ultra5000 operation.	Verify voltage level of the incoming AC power. Check AC power source for glitches or line drop (below 90V AC). Install an uninterruptible power supply (UPS) on your AC input.
10	Bus Overvoltage	Excessive regeneration of power. When the motor is driven by an external mechanical power source, it may regenerate too much peak energy through the Ultra5000's power supply. The system faults to save itself from an overload.	Change the deceleration or motion profile. Use a larger system (motor and Ultra5000). Use an Active Shunt.
		Excessive AC input voltage.	Verify input is below 264V AC.
		Output short circuit.	Check for shorts.
		Motor cabling wires shorted together.	Check for shorts.
		Internal motor winding short circuit.	Check for shorts.
11	Illegal Hall State	Incorrect phasing.	Check the Hall phasing.
		Bad connections.	Verify the Hall wiring.
12 to 19	RESERVED		
20	Motor Encoder State Error	The motor encoder encountered an illegal transition.	Replace the motor/encoder. Use shielded cables with twisted pair wires. Route the feedback away from potential noise sources. Check the system grounds. Ensure digital filtering of encoder signals is enabled.
		Bad encoder.	Replace motor/encoder.
21	Auxiliary Encoder state error	The auxiliary encoder encountered an illegal transition.	Use shielded cables with twisted pair wires. Route the encoder cable away from potential noise sources. Bad encoder - replace encoder. Check the ground connections.
22	Motor Thermal Protection Fault	The internal filter protecting the motor from overheating has tripped.	Reduce acceleration rates. Reduce duty cycle (ON/OFF) of commanded motion. Increase time permitted for motion. Use larger Ultra5000 and motor.
23	IPM Thermal Protection Fault	The internal filter protecting the IPM at slow speed has tripped.	Reduce acceleration rates. Reduce duty cycle (ON/OFF) of commanded motion. Increase time permitted for motion. Use larger Ultra5000 and motor.
24 to 99	RESERVED		Call your local Allen-Bradley representative.

Specifications and Dimensions

Chapter Objectives

This chapter covers:

- Ultra5000 specifications
- Dimensions

Ultra5000 Specifications

This section lists the specifications for the Ultra5000.

General Power Specifications

The table below lists general power specifications and requirements.

Specification	Description		
	IPD-005	IPD-010	IPD-020
AC Input Voltage and Frequency	100-240 Vac _{rms} nominal Single Phase, 47 - 63 Hz	100-240 Vac _{rms} nominal Single Phase, 47 - 63 Hz	100-240 Vac _{rms} nominal Single Phase, 47 - 63 Hz
AC Input Current	5 A _{rms}	9 A _{rms}	18 A _{rms}
Bus Voltage	141-339 Vdc	141-339 Vdc	141-339 Vdc
Output Peak Current (0-peak)	7.5 Amps	15 Amps	30 Amps
Continuous Output Current (0-peak)	2.5 Amps	5 Amps	10 Amps
Bus Capacitance Energy Absorption (from 325-400 Vdc Bus) ⁽¹⁾	51 Joules 1880μF	51 Joules 1880μF	51 Joules 1880μF
Peak Power Output ⁽²⁾	120 V AC 0.75 kWatts 240 V AC 1.5 kWatts	120 V AC 1.5 kWatts 240 V AC 3.0 kWatts	120 V AC 3.0 kWatts 240 V AC 6.0 kWatts
Continuous Power Output	120 V AC 0.25 kWatts 240 V AC 0.5 kWatts	120 V AC 0.5 kWatts 240 V AC 1.0 kWatts	120 V AC 1.0 kWatts 240 V AC 2.0 kWatts

⁽¹⁾ Bus capacitance energy absorption is based on the following equations:

$$E = \frac{1}{2}C(V^2f) - \frac{1}{2}C(V^2i)$$

$$E = \frac{1}{2}C(400)^2 - \frac{1}{2}C(325)^2$$

$$\frac{1}{2}C \cdot (400^2 - 325^2) = C(27187)$$

$$\text{if } C = 4 \times 470\mu F \quad E = 51$$

⁽²⁾ Peak Power is system and speed dependent and is not tested for the Drive alone.

Physical and Environmental

The table below lists physical and environmental specifications and requirements.

Specification	Description
IPD-005	1.77 Kg (3.9 lbs)
IPD-010	2.06 Kg (4.55 lbs)
IPD-020	2.05 Kg (4.51 lbs)
Operating Temperature	0°C to 55°C (32°F to 131°F)
Storage Temperature	-40°C to 70°C (-40°F to 158°F)
Humidity	5% to 95% non-condensing
Altitude	1500 meters (5000 ft) Derate 3% for each 300 m above 1500 meters
Vibration	10 to 2000 Hz @ 2g
Shock	15g 11 millisecond half sine

Power Dissipation

The maximum power losses are shown below to help in sizing an enclosure and any required ventilation. Typical heat losses can run approximately one-half maximum power losses.

Model	Maximum Loss (Watts)
IPD-005	48 + dissipative shunt
IPD-010	48 + dissipative shunt
IPD-020	50 + dissipative shunt

User Programming

The table below lists physical and programming specifications.

Specification	Description
Language	Compiled ANSI C with Library of Motion Functions
Programming Environment	Full-featured Color Syntax Editor and C Compiler Integrated with Ultraware
Operating System	Real-time, multi-tasking, field upgradable flash
User Program Memory	512 Kbytes
	Flash Memory, 100,000 Write Cycles
Non-Volatile Memory	32 Kbytes (approximately 8000 non-volatile user variables)
	nvSRAM (High speed SRAM/EEPROM)

Controller

The table below lists controller specifications.

Specification	Description
Processor	Texas Instruments TMS320C32 32 Bit Floating Point Digital Signal Processor
Clock Speed	60 MHz
Commutation	3 Phase Sinusoidal, Space Vector Modulated (SVM)
Current Loop	SVM - 125 μ sec update rate
Velocity Loop	Digital PI - 250 μ sec update rate
Position Loop	Digital PI - 500 μ sec update rate
Position Range	32-bit signed
Velocity Range	32-bit floating point
Acceleration Range	32-bit floating point
Electronic Gearing	64-bit signed

Inputs and Outputs

The table below lists I/O specifications.

Specification	Description
General Purpose Digital Inputs	16 Optically Isolated 12-24 Volt Inputs
Inputs/Outputs - Sinking/Sourcing Selection	Software Selectable as a Group to be Active High, Current Sinking or Active Low, Current Sourcing
General Purpose Digital Outputs	7 Optically Isolated 12-24 Volt Outputs - 50 Milliamperes Maximum
General Purpose Relay Output	1 Normally Open Relay - 30 Volts DC Maximum, 1 Ampere Maximum Current
General Purpose I/O Response	100 μ sec
High Speed Input Response	< 1 μ sec (Inputs 1 and 2)
Position Capture Response	< 1 μ sec (Input 1, Input 2, Motor Encoder Index, and Auxiliary Encoder Index)
General Purpose Analog Inputs	2 12-Bit Analog to Digital Converters (+/- 10V, single-ended)
General Purpose Analog Outputs	2 12-Bit Digital to Analog Converters (+/- 10V, +/- 2mA, single-ended)

Communications

The table below lists communication specifications.

Specification	Description
Serial	2 Independent RS-232/RS-422/RS-485 Ports, 1200-38,400 Baud

Motor Feedback

The table below lists motor feedback specifications.

Specification	Description
Input Modes	Incremental with Index
Maximum Input Frequency	2.5 MHz (Encoder Lines)
Commutation Feedback	Hall Sensor

Auxiliary Feedback

The table below lists auxiliary feedback specifications.

Specification	Description
Operation	Auxiliary Feedback Input
Input Modes	A quad B
Input Type	Line Receiver
Maximum Input Frequency	2.5 MHz (Encoder Lines)

Connectors

The table below lists connector specifications.

Specification	Description
Digital I/O Connector CN1A	28 Position Plugable Spring Clamp Terminal Block
Auxiliary Feedback/Analog I/O Connector CN1B	14 Position Plugable Spring Clamp Terminal Block
Motor Feedback Connector CN2	15 Position High Density Female D-Sub Connector
Serial Port Connectors CN3A and CN3B	9 Position Female D-Sub Connector
Main AC, Motor Power, and DC Bus Connector	9 Position Screw Terminal Block

Dimensions

The following diagrams show the dimensions and mounting hole locations for the 2098-IPD-005, -010, and -020.

Figure A.1
Ultra5000 500W Mounting Diagram

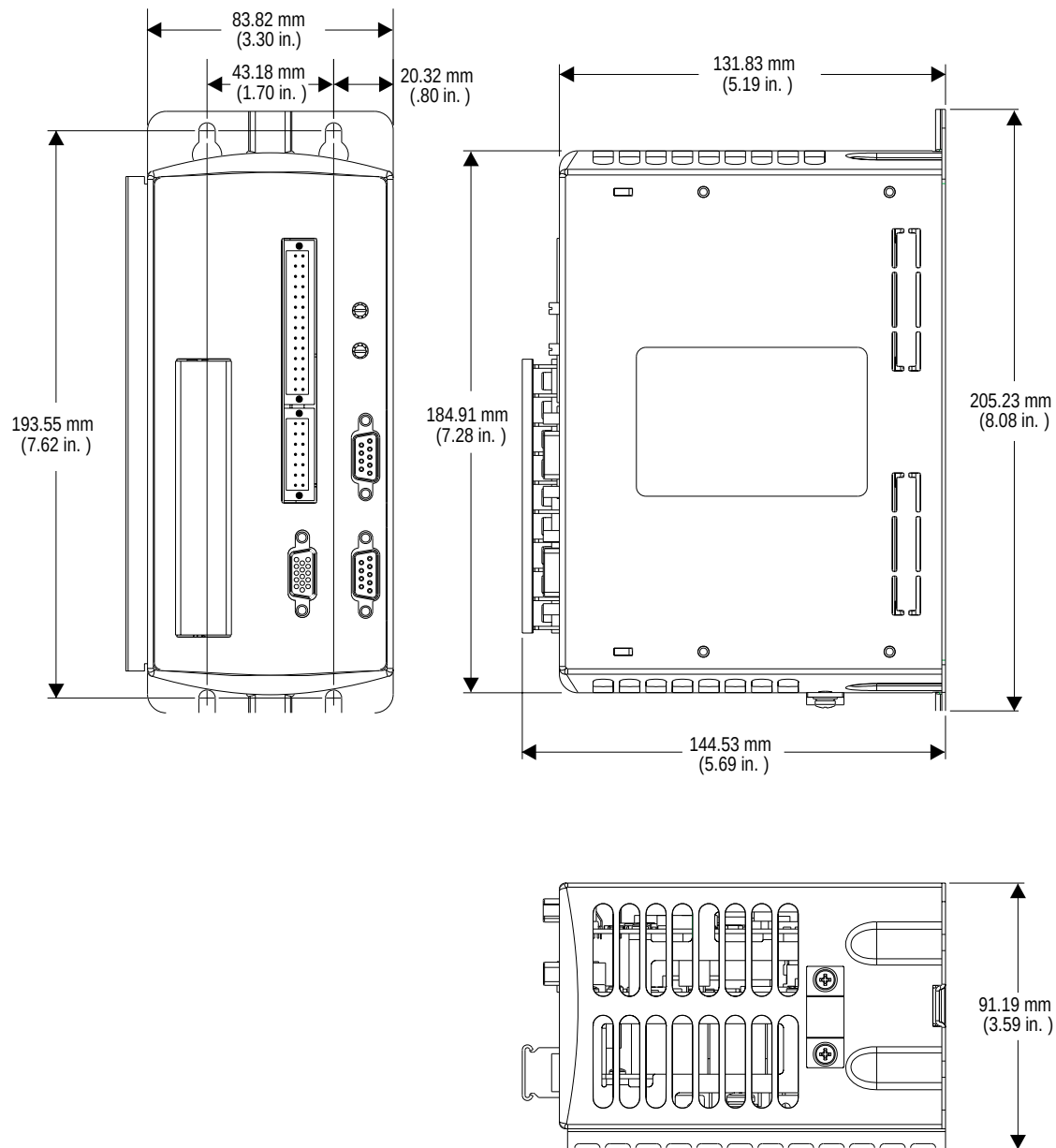
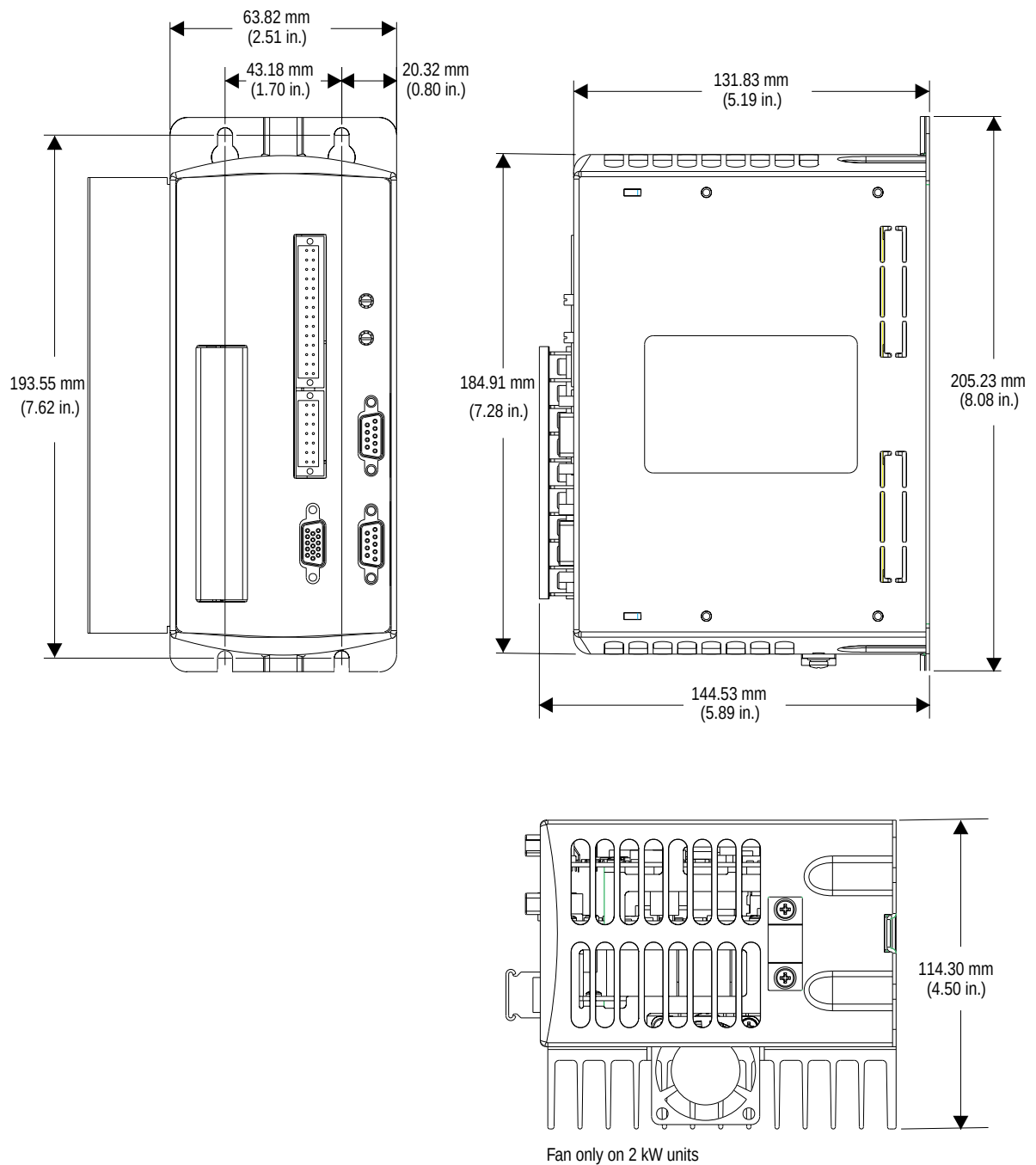


Figure A.2
Ultra5000 1 kW & 2 kW Mounting Diagram



Options and Accessories

Chapter Objectives

This appendix provides the Ultra5000 options and accessory catalog numbers. This appendix covers catalog numbers for the:

- Ultra5000 family
- Ultra5000 accessories
- Motor power cables
- Motor feedback cables
- Interface cables

Contact your local Allen-Bradley sales office for additional information.

Ultra5000 Family

The Ultra5000 has power ratings from 500W to 15 kW. The Ultra5000 family models are listed in the following table.

Model	Description	Power Rating
2098-IPD-005	Ultra5000 Intelligent Positioning Drive	500W
2098-IPD-010	Ultra5000 Intelligent Positioning Drive	1 kW
2098-IPD-020	Ultra5000 Intelligent Positioning Drive	2 kW

Option Cards

Option cards added to the Ultra5000 Series drives are indicated by a suffix after the model number. In the event that two option cards are added to the drive, the model number will include a slash (/) between the option board designators.

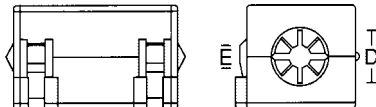
Ultra5000 Accessories

External Shunt Kit

Only the Active Shunt can be used with the Ultra5000. Use the following table to identify your External Shunt.

Description	Catalog Number
Active Shunt Module (300W)	2090-UCSR-A300

Ferrites are used at both ends of the DC Bus wires for CE radiated emissions compliance. Use the following table to select a ferrite assembly.

Box shaped ferrite assembly in fully enclosed nylon case. End ports are surrounded with flexible spring flutes to grip a range of cable diameters from .125 to .500" (3.2 to 12.7mm). FerriShield, Inc. 350 Fifth Avenue, Suite 7310 New York, NY 10118-7591			
Mfg. Part/No.	D	E	Impedance
SS28B2034	0.250	0.120	125 Ω
SS28B2037	0.350	0.200	154 Ω
SS28B2032	0.500	0.200	230 Ω

AC Line Filters

A single filter per Ultra5000 would have a matching fuse rating of 6, 10, 23, 36, 50, or 70 AMPS respectively. Use the following table to identify the AC Line Filter for your application.

Description	Catalog Number
AC Line Filter (6 Amp, Single phase)	2090-UXLF-106
AC Line Filter (10 Amp, Single phase)	2090-UXLF-110
AC Line Filter (23 Amp, Single phase)	2090-UXLF-123
AC Line Filter (36 Amp, Single phase)	2090-UXLF-136
AC Line Filter (36 Amp, Three phase)	2090-UXLF-336
AC Line Filter (50 Amp, Single phase)	2090-UXLF-150
AC Line Filter (50 Amp, Three phase)	2090-UXLF-350
AC Line Filter (70 Amp, Three phase)	2090-UXLF-370

Mating Connector Kits

The Ultra5000 has two serial connectors, one motor feedback connector, two I/O connectors and one terminal block for power connections. Connectors are D-shell type except for the terminal block connector and the I/O connectors. The I/O connectors are plugable connectors and are not available in a connector kit. Refer to the chapter *Connecting Your Ultra5000* for pin and signal information for wiring the connectors.

Description	Catalog Number
Mating Connector Kit (9 pin D-Shell, serial interface)	2090-UXCK-D09
Mating Connector Kit (15 pin D-Shell, motor feedback)	2090-UXCK-D15
Mating Connector Kit (Terminal Block)	2090-UXCK-TB

Break Out Board, Cables, and Kits

Use the following table to identify your break out board components.

Description	Catalog Number
Break Out Board	2090-UXBB-D15
Break Out Board cable (14 Pin, D-Shell)	2090-UXBC-D1501
Break Out Board cable (28 Pin, D-Shell)	2090-UXBC-D1503
Break Out Board Kit (14 Pin, D-Shell)	2090-UXBK-D1501
Break Out Board Kit (28 Pin, D-Shell)	2090-UXBK-D1503

Motor Power Cables

Use the following table to identify motor power cables for your F, H, MP, N, and Y-Series motors. Length of cable xx is in meters (01, 03, 09, 15, and 30).

Description	Catalog Number
H-2000/3000 Series Motor Power Cable, up to 2 kW Ultra3000/5000, (non flex, 16 AWG, straight angle)	2090-UXNPA-H16Sxx
F-4000 Series Motor Power Cable, 2 and 3 kW Ultra3000/5000, (non flex, 14 AWG, straight angle)	2090-UXNPA-F14Sxx
H-4000 Series Motor Power Cable, 2 and 3 kW Ultra3000/5000, (non flex, 14 AWG, straight angle)	2090-UXNPA-H14Sxx
MP-Series Motor Power Cable, up to 2 kW Ultra3000/5000, (non flex, 16 AWG, straight angle)	2090-UXNPA-MP16Sxx
N-Series Motor Power Cable, Ultra3000/5000, (non flex, 16 AWG, straight angle)	2090-UXNPA-N16Sxx
Y-Series Motor Power Cable, Ultra3000/5000, (non flex, 16 AWG, straight angle)	2090-UXNPA-Y16Sxx

Motor Feedback Cables

Use the following table to identify motor feedback cables for your F, H, MP, N, and Y-Series motors. Length of cable xx is in meters (01, 03, 09, 15, and 30).

Description	Catalog Number
F-Series Motor Feedback Cable, Ultra3000/5000, (Feedback to drive)	2090-UXNFB-FSxx
F-Series Motor Feedback Cable, (Feedback to no connector)	2090-UXNFD-FSxx
H-Series Motor Feedback Cable, Ultra3000/5000, (Feedback to drive)	2090-UXNFB-HSxx
H-Series Motor Feedback Cable, (Feedback to no connector)	2090-UXNFD-HSxx
MP-Series Motor Feedback Cable, Ultra3000/5000, (Feedback to drive)	2090-UXNFB-MPSxx
MP-Series Motor Feedback Cable, (Feedback to no connector)	2090-UXNFD-MPSxx
N-Series Motor Feedback Cable, Ultra3000/5000, (Feedback to drive)	2090-UXNFB-NSxx
N-Series Motor Feedback Cable, (Feedback to no connector)	2090-UXNFD-NSxx
Y-Series Motor Feedback Cable, Ultra3000/5000, (Feedback to drive)	2090-UXNFB-YSxx
Y-Series Motor Feedback Cable, (Feedback to no connector)	2090-UXNFD-YSxx

Interface Cables

Use the following table to identify controller cables for your Ultra5000. Length of cable xx is in meters (01, 03, 09, and 15).

Description	Catalog Number
Interface Cable to Ultra3000/5000 (Computer Connection)	2090-UXPC-D09xx

Application Information

Chapter Objectives

The following information is considered application specific and does not apply to all installations. This appendix covers the following topics:

- Mechanical resonance
- Using an emergency stop contactor
- Grounding for Ultra5000 CE requirements
- Building your own cables

For additional information contact your local Allen-Bradley sales representative.

Mechanical Resonance

Mechanical resonance between the motor and the load occurs when the motor and load are oscillating with the same frequency but opposite phase (when the motor is moving clockwise the load is moving counter clockwise). The amplitude of the motor and load oscillations is such that the total momentum of the oscillating system is zero. Mechanical resonance occurs as a result of compliance between the motor inertia and load inertia. It may result from belts, flexible couplings or the finite torsional stiffness of shafts. In general, the stiffer the couplings, the higher the resonant frequency and lower the amplitude. If the motor shaft is directly coupled to the load, a mechanically resonating system usually emits a buzz or squeal at the motor.

There are several ways of dealing with this problem, but they generally fall into one of two groups:

- Change the mechanical system
- Change the servo motor response

Changing the mechanical system might involve reducing the inertia ratio via gearboxes or pulleys, or by increasing the stiffness of the couplings. For very high performance systems and systems with low resonance frequencies the mechanics may require changing to effectively deal with the resonance.

Changing the servo motor response is done by reducing the P-gain, I-gain, or low-pass filter value.

Reducing the value of the P-gain and low-pass filter frequency have the effect of reducing the servo motor bandwidth. This is acceptable as long as the resonating frequency is fairly high. But, if the resonating frequency is low it may be necessary to modify the mechanics of the system.

Backlash

Backlash between the motor and load effectively unloads the motor over a small angle. Within this small angle, the increased gain can result in oscillations. Some backlash may be unavoidable, especially with gear reduction. If backlash is present, the inertia match between the load and motor must be properly sized for good servo performance (load inertia should roughly equal motor inertia). Gearing reduces the inertia reflected to the motor by the square of the gear reduction from motor to load. Therefore, the gear ratio must provide the required match.

Using an Emergency Stop Contactor

Some applications require that a contactor be inserted between the motor and Ultra5000 for emergency stop purposes. To determine if this is necessary, perform a hazard analysis of the machine. If used, the contactor must not simply break the motor current, it must switch a 3-phase resistive load in parallel with the motor windings. The three resistors provide dynamic braking and a category zero stop. The resistors also prevent continuous arcing at the main contacts when breaking DC currents, such as when the motor is at stall.

It is important to sequence the E-stop string to disable the drive prior to or at the same time the contactor is released. Conversely, upon power-up the contactor must be fully engaged before the drive is enabled. Use an auxiliary contact on the contactor for the drive enable circuit for sequencing.

ATTENTION

To avoid personal injury and/or equipment damage, do not simply break the motor current. This can result in very high voltages due to motor inductance, prolonged arcing in the contactor, and eventually can cause fire in extreme cases.

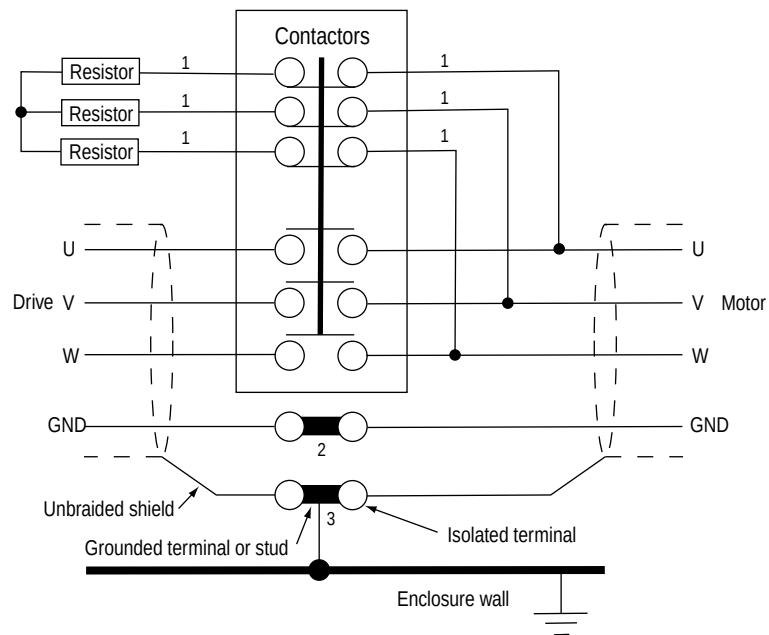
Shield and ground cable connection methods are shown in Figure C.1.

ATTENTION



Implementation of safety circuits and risk assessment is the responsibility of the machine builder. Please reference international standards EN1050 and EN954 estimation and safety performance categories. For more information refer to *Understanding the Machinery Directive* (publication SHB-900).

Figure C.1
Emergency Stop Contactor Wiring



¹ Exposed power wiring conductors that are not shielded are a source of RFI noise. Keep exposed conductors as short as possible and isolated from sensitive devices and wiring.

² The safety ground (GND) and shield connections are permanently connected. This is essential for electrical safety.

³ Unbraid all cable shields and bond together, connecting directly to the grounded terminal or stud. Do not use the shield drain wire for this bonded connection.

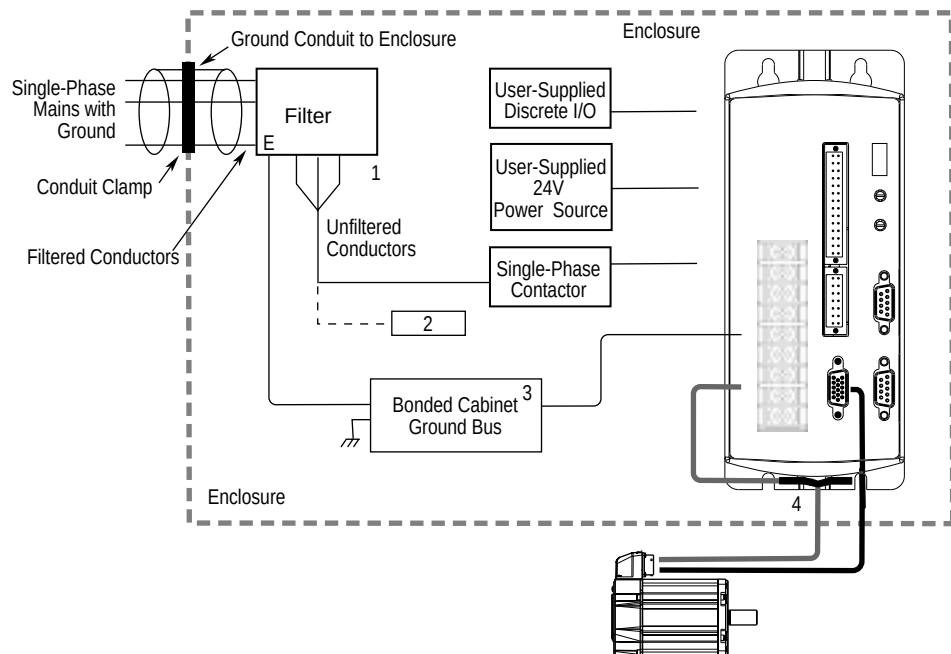
IMPORTANT

The safety ground is not connected to local ground at the point where the contactor is inserted in the lines, but the shield is. This is done for EMC reasons.

Grounding for Ultra5000 CE Requirements

Refer to the figure below for Ultra5000 CE requirements.

Figure C.2
Ultra5000 CE Requirements



¹ Mount the filter as close to the Ultra5000 as possible. If the distance exceeds 600 mm (2.0 ft), use a strap (greater in width than length) rather than a wire, to connect the ground between the Ultra5000 and the filter. This is particularly important for attenuation of higher frequency emissions (5-30 MHz).

Shield or separate the wires connecting the AC power to the filter from other power cables (e.g., connections between the Ultra5000 and the filter, motor power cable, etc.). The best method of achieving this is to mount the filter near where the AC power enters the enclosure. If the connections are not separated from each other, the EMI on the Ultra5000 side of the filter can couple over to the source side of the filter, thereby reducing or eliminating the filter's effectiveness. The coupling mechanism can radiate or allow stray capacitance between the wires.

Filters need to be on all lines for filtering to be effective. When multiple power cables enter an enclosure, an unfiltered line can contaminate a filtered line.

Bond the filter and the Ultra5000 to a grounded conductive surface (the enclosure) to establish a high frequency (HF) connection. To achieve the HF ground, the contact surface interface between the filter, Ultra5000, and the enclosure should be free from paint or any other type of insulator.

² The filter shown is sized for one Ultra5000. Equivalent filters may be used for multiple units. Size the filter following the manufacturers recommendations.

³ Ground bar is customer-supplied item.

⁴ Clamp motor power cable shield for EMC termination.

IMPORTANT

All single-phase power in the cabinet must be filtered to reduce EMI.

ATTENTION



High voltage exists in AC line filters. The filter must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels. Failure to observe this precaution could result in personal injury.

Building Your Own Cables

This section provides information to assist you in building your own cables. Allen-Bradley power and feedback cables are available and recommended for robust system integrity to EMI. Refer to *Appendix B* for cable catalog number information. For motor and encoder connector kit and wiring information refer to the appropriate Allen-Bradley motor product data publication.

Building Your Own Cables

When building your own cables follow the guidelines listed below.

- Connect the cable shield to the motor case and to the Ultra5000 chassis through the connectors for a complete 360° connection (per the cable assembly diagram).
- Use a 4-conductor cable, with the 4 conductors twisted.
- Attach a ground conductor to the motor and the Ultra 5000 earth terminal.

Persistent EMI Problems

If EMI problems persist, use ferrite doughnuts or torroids around signal cables. The ferrite will attenuate common mode noise but will do nothing for differential mode noise. Specifically, ferrite doughnuts help RS232 communication noise problems by:

- Suppressing EMI at each switched inductive device that is near the servo amplifier. This includes solenoids, relay coils, starter coils, and AC motors (such as in motor driven mechanical timers).
- Suppressing EMI at DC coils with a “fly-back” (1N4004) diode connected across the coil.
- Suppressing EMI at AC coils with RC filters (e.g., a 200 ohm 1/2 watt resistor in series with a 1/2 micro farad, 600 volt capacitor).
- Suppressing EMI at motor power windings by grounding, shielding, and filtering.

Refer to Figure C.3 and Figure C.4 for additional information.

Figure C.3
Torroid Encoder Shielding Method for Brushless Servo Motors

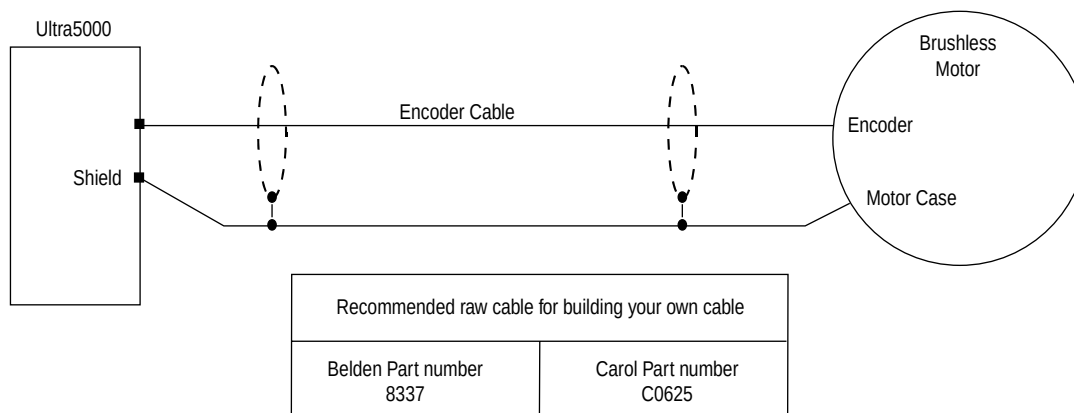
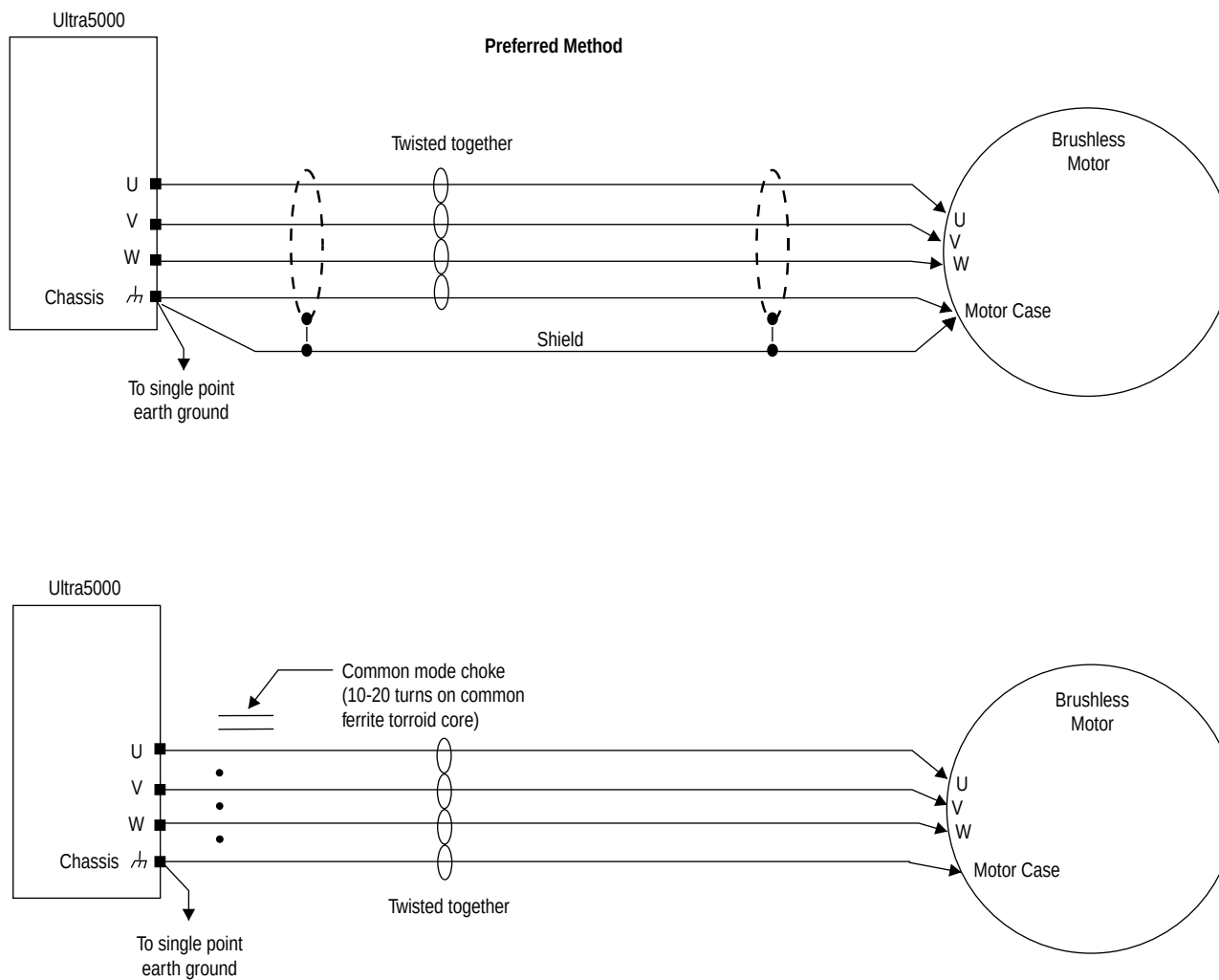


Figure C.4
Motor Power Winding Methods to Minimize Noise Emissions



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